NEW FAYETTE COUNTY PRISON
MULTI PRIME

245 McClellandtown Road
Uniontown, PA 15401

VOLUME 03: Sections 21-33

PROJECT NO. 20-1737

February 23, 2021

Reynolds
3300 North 3rd St.
Harrisburg, PA 17110
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Specifications for this project are arranged in accordance with the construction specifications institute numbering system and format. Section numbering is continuous and all numbers not appearing in the table of contents are not used for this project.

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SECTION 21 0500
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Pipe, fittings, sleeves, escutcheons, seals, and connections for sprinkler and combination sprinkler and standpipe systems.

1.03 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 09 9113 - Exterior Painting: Preparation and painting of exterior fire protection piping systems.

C. Section 09 9123 - Interior Painting: Preparation and painting of interior fire protection piping systems.

D. Section 21 0553 - Identification for Fire Suppression Piping and Equipment: Piping identification.

E. Section 21 1300 - Fire-Suppression Sprinkler Systems: Sprinkler systems design.

F. Section 21 3000 - Fire Pumps.

1.04 REFERENCE STANDARDS

A. ASME A112.18.1 - Plumbing Supply Fittings.

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.

D. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250.

E. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard.

F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

G. ASTM A135/A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe.

H. ASTM A536 - Standard Specification for Ductile Iron Castings.

I. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.

J. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).

K. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.

L. AWS D1.1/D1.1M - Structural Welding Code - Steel.

M. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.

N. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

O. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.

P. AWWA C606 - Grooved and Shouldered Joints.

Q. NFPA 13 - Standard for the Installation of Sprinkler Systems.

R. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.

S. UL (DIR) - Online Certifications Directory.

1.05 SUBMITTALS

A. Product Data: Provide manufacturers catalog information. Indicate valve data and ratings.

B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

C. Project Record Documents: Record actual locations of components, piping, nodes and tag numbering.

D. Operation and Maintenance Data: Include installation instructions and spare parts lists.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified this section.

1. Minimum 5 experience.

C. Conform to UL and FM requirements.

D. Valves: Bear UL and FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

E. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

F. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.07 DEFINITIONS

A. High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig.

B. Underground Service-Entrance Piping: Underground service piping below the building.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers, with labeling in place.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

PART 2 PRODUCTS

2.01 FIRE PROTECTION SYSTEMS

A. Sprinkler Systems: Comply with NFPA 13.

B. Standpipe and Hose Systems: Comply with NFPA 14.

C. Fire Pumps: Comply with NFPA 20.

D. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.02 PIPE, FITTINGS, AND JOINTS

A. Pipe and fittings shall conform to the latest ANSI, ASTM, NFPA, and AWWA Standards, including amendments.

B. Each pipe fitting, material and/or device used in the Fire Protection System shall have cast stamped, or indelibly marked on it, the manufacturers name or mark, weight, and quality of the product when such marking is required by the approved standard that applies.

C. Pipe shall be new, designed for system working pressure, and have the manufacturer's name or brand along with the pipe applicable ASTM Standard marked on each length of pipe.

2.03 BURIED PIPING

A. Ductile Iron Pipe: AWWA C151/A21.51.
   1. Fittings: AWWA C110/A21.10, standard thickness.
   2. Joints: AWWA C111/A21.11, styrene butadiene rubber (SBR) or vulcanized SBR gasket.
   3. Mechanical Couplings: Shaped composition sealing gasket, steel bolts, nuts, and washers.

B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.

C. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern AWWA C153, ductile-iron compact pattern.

D. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.

E. Gaskets: AWWA C111, rubber.

2.04 ABOVE GROUND PIPING

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed threaded ends.
   1. Cast-Iron Threaded Flanges: ASME B16.1.
   2. Malleable-Iron Threaded Fittings: ASME B16.3.
   3. Gray-Iron Threaded Fittings: ASME B16.4.
   4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
   5. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.

B. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed, roll-grooved ends.
   1. Grooved-Joint Piping Systems Manufacturers:
      a. Anvil International, Inc.
      b. Tyco Fire Products
      c. Victaulic Co. of America.
   2. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting or ASTM A 53, carbon steel fittings with OD matching steel-pipe OD.
   3. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated synthetic rubber gasket listed for use with housing, and steel bolts and nuts.
      a. Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13. UL/ FM
         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. Victaulic Style 107H QuickVic™ (2" - 8"). or approved equal.
      b. Flexible Type: Use in seismic areas and where required by NFPA 13.
         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.

Victaulic Style 177 QuickVic™. or approved equal

c. Couplings gaskets shall be as recommended by the coupling manufacturer for dry, wet and freezer systems applications and for ambient or temperature range in each system.

d. Flange adapters shall be ASTM A 536, ductile iron castings, flat faced, designed for incorporating flanged components with ANSI Class 125 and 150 bolt-hole patterns to a grooved piping system. Victaulic Style 741 or 744 or approved equal.

C. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 2-1/2 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10; with factory- or field-formed, roll-grooved ends.

1. Grooved-Joint Piping Systems Manufacturers:
   a. Anvil International, Inc.
   b. Tyco Fire Products
   c. Victaulic Co. of America.
2. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting or ASTM A 53, carbon steel fittings with OD matching steel-pipe OD.
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   d. Flange adapters shall be ASTM A 536, ductile iron castings, flat faced, designed for incorporating flanged components with ANSI Class 125 and 150 bolt-hole patterns to a grooved piping system. Victaulic Style 741 or 744 or approved equal.

D. Welded Outlets: Standard-Weight, schedule 10, Black or Galvanized: 1-1/4" and larger. Welding shall be performed in accordance NFPA 13.

2.05 PIPE SLEEVES

A. Vertical Piping:
1. Sleeve Length: 1 inch above finished floor.
2. Provide sealant for watertight joint.

B. Pipe Passing Through Below Grade Exterior Walls:
1. Zinc coated or cast iron pipe.
2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.

C. Clearances:
1. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
2. Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

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

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

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

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

2.06 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Manufacturers:
   1. Advance Products & Systems, Inc: www.apsonline.com.
   2. Link Seal.
   3. Calpico,Inc
   4. Metraflex Co.
   5. Substitutions: See Section 01 6000 - Product Requirements.

B. Modular/Mechanical Seal:
   1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
   2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Provide watertight seal between pipe and wall/casing opening.
   4. Elastomer element size and material in accordance with manufacturer's recommendations.
   5. Glass reinforced plastic pressure end plates.
   6. Pressure Plates: Stainless steel. Include two for each sealing element.
   7. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.07 ESCUTCHEONS

A. Manufacturers:
   1. Fire Protection Products, Inc: www.fppi.com.com.
   2. Tyco Fire Protection Products: www.tyco-fire.com.
   3. Viking Group Inc: www.vikinggroupinc.com.
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Material:
   1. Fabricate from nonferrous metal.
   2. Chrome-plated.
   3. Metals and Finish: Comply with ASME A112.18.1.

C. Construction:
   1. One-piece for mounting on chrome-plated pipe and split-pattern type elsewhere.
   2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.08 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. Grinnell Pipe Corporation, Cranston, RI
   2. Michigan Hanger Company
   3. PHD Manufacturing, Columbia, OH

B. Hangers for Fire Protection piping shall be UL and FM approved.

C. Hangers shall be the type approved by NFPA.

D. Rods, clamps, and hangers shall be electrogalvanized coated.

2.09 MECHANICAL COUPLINGS

A. Manufacturers:
   1. Tyco Fire Protection Products; Grinnell G-Fire Figure 705 Grooved Flexible Couplings: www.tyco-fire.com/#sle.
   2. Victaulic Company; FireLock Style 009H: www.victaulic.com/#sle.
   3. Substitutions: See Section 01 6000 - Product Requirements.

B. Rigid Mechanical Couplings for Grooved Joints:
   1. Dimensions and Testing: Comply with AWWA C606.
   2. Minimum Working Pressure: 300 psig.
   3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
   4. Housing Coating: Factory applied orange enamel.
   5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
   6. Bolts and Nuts: Hot dipped galvanized or zinc electroplated steel.
   7. Provide stops for direct stab installation without field assembly.

2.10 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.

B. Gate Valves with Wall Indicator Posts:
   1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, non-rising stem, operating nut, and flanged ends. Iron body indicator post assembly.
   2. Gate Valves: UL 262, ductile-iron body, bronze mounted, resilient wedge, non-rising brass stem, operating nut, and grooved ends. Tyco OS&Y Gate Valve Victaulic Style 772 or equal by the Professional.
   3. Manufacturers:
      a. NIBCO.
      b. Tyco Fire Products.
      c. Victaulic Co.

C. Ball Valves: Comply with UL 1091, except with ball instead of disc.
   1. NPS 1-1/2 and Smaller: Bronze body with threaded or grooved ends.
   2. NPS 2: Bronze body with threaded ends or with grooved ends.
   3. Design: Weather-proof actuator with two pre-wired supervisory switches.
   4. Manufacturers:
      a. NIBCO.
      b. Victaulic Co. of America. Victaulic FireLock® Series 728 or approved equal.
      c. Grovlok

D. Butterfly Valves: UL 1091.
   1. NPS 2 and Smaller: Bronze body with threaded ends.
   2. Manufacturers:
      a. Global Safety Products, Inc.
      b. Milwaukee Valve Company.
   3. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.

E. Grooved End Butterfly Valves: Ductile iron body, nickel-plated ductile iron disc, Nitrile seat, weather-proof actuator with two pre-wired supervisory switches, 365 maximum pressure rating.
   1. Manufacturers:

a. McWane, Inc.; Kennedy Valve Div.
b. Mueller Company
c. NIBCO
d. Tyco Fire Products-Model BFV-N
e. Victaulic Co. of America. Victaulic FireLock® Series 765 and 705 or approved equal.

F. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
1. Manufacturers:
a. Grinnell Fire Protection.
b. NIBCO.
c. Reliable Automatic Sprinkler Co., Inc.
d. Victaulic Co. of America.

G. Spring-Loaded Check Valves, NPS 2 and Larger: UL 312, ductile iron body, stainless steel or EPDM coated ductile iron disc, stainless steel spring, grooved ends.
1. Manufacturer:
a. Victaulic Series 717H and 717

H. Gate Valves: UL 262, OS&Y type.
1. NPS 2 and Smaller: Bronze body with threaded ends.
2. Manufacturers:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Hammond Valve.
c. NIBCO.
d. United Brass Works, Inc.
3. NPS 2-1/2 and Larger: Cast-iron body with flanged ends or ductile iron body with grooved ends.
4. Manufacturers:
a. Milwaukee Valve Company
b. Mueller Company
c. NIBCO
d. Tyco Fire Products
e. Victaulic Series 771.

I. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.
1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch.
2. NPS 2 and Smaller: Ball valve with bronze body and threaded or grooved ends.
3. Manufacturers:
a. Milwaukee Valve Company.
b. NIBCO.
c. Victaulic Co. of America.
4. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.
5. Manufacturers:
a. McWane, Inc.; Kennedy Valve Div.
b. Milwaukee Valve Company.
c. NIBCO.
d. Victaulic Co. of America.

2.11 DOUBLE DETECTOR CHECK VALVE

A. Manufacturers:
1. Ames Company, Woodland, PA

2. Conbraco, Matthews, N.C.
3. Watts, Lawrence, MA
4. Zurn Wilkins

B. Double check valve assembly Model 300SS as manufactured by Ames or approved equal.

C. Elevated Bypass: Comprised of a shutoff valves, double check valve, and a Senus Model SR meter, reading cubic feet. Meter shall be as specified, or as otherwise approved by the Water Authority and the Engineer.

D. Meter shall be of type as required by the Municipal Water Department.

2.12 FIRE DEPARTRMENT CONNECTIONS

A. Manufacturers:
1. AFAC Inc.
2. Elkhart Brass Mfg. Co., Inc.
3. Fire-End and Croker Corp.
4. Guardian Fire Equipment Incorporated.
5. Potter-Roemer; Fire-Protection Div.
6. Reliable Automatic Sprinkler Co., Inc.

B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."

C. Verify the exact type of fire department connection and acceptable location with the Local Fire Department prior to installation.

D. Finish: Polished chrome-plated or type as requested by the Fire Department.

2.13 INDICATOR POSTS

A. Manufacturers:
1. Elkhart Brass Mfg. Co., Inc.
2. Guardian Fire Equipment Incorporated.
3. Potter-Roemer; Fire-Protection Div.

B. Vertical indicator post or wall indicator as shown on the drawings shall be FM approved, Ul listed, and as approved by the local Fire Department.

C. Finish: Polished chrome-plated or type as requested by the Fire Department

2.14 ALARM DEVICES

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

B. Water-Motor-Operated Alarm: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch- diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 inlet and NPS 1 drain connections.
1. Manufacturers:
   a. Reliable Automatic Sprinkler Co., Inc.
   b. Victaulic Co.
   c. Viking Corp.

C. Electrically Operated Alarm: UL 464, with 10-inch diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.
1. Manufacturers:

a. Potter Electric Signal Company.
b. System Sensor.
c. Viking Corp.

D. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include 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.
1. Manufacturers:
a. ADT Security Services, Inc.
b. Potter Electric Signal Company.
c. System Sensor.
d. Viking Corp.

E. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
1. Manufacturers:
a. McWane, Inc.; Kennedy Valve Div.
b. Potter Electric Signal Company.
c. System Sensor.

2.15 PRESSURE GAGES

A. Manufacturers:
1. AGF Manufacturing Co.
2. AMETEK, Inc.; U.S. Gauge.
3. Brecco Corporation.
4. Dresser Equipment Group; Instrument Div.
5. Marsh Bellofram.
6. WIKA Instrument Corporation.

B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.

C. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.

2.16 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, non gaseous, 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

3.01 PREPARATION

A. Remove scale and foreign material, from inside and outside, before assembly.

B. Perform fire-hydrant flow test according to NFPA 13. Use results for system design calculations.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Remove scale and foreign material, from inside and outside, before assembly.

B. Install piping according to the requirements of Division 21 Sections specifying piping systems.

C. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping according to approved sprinkler hydraulic design drawings.

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.

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

G. Install piping to permit valve servicing.

H. Install piping free of sags and bends.

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

J. 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.

3.03 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure.
   1. NPS 1-1/2 and Smaller: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
   2. NPS 2: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
   3. NPS 2: Grooved-end, black or galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
   4. NPS 2-1/2 to NPS 3: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
   5. NPS 2-1/2 to NPS 3: Grooved-end, black or galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
   6. NPS 2-1/2 to NPS 3: Grooved-end, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
   7. NPS 4 to NPS 6: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
   8. NPS 4 to NPS 6: Grooved-end, black or galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
   9. NPS 4 to NPS 6: Grooved-end, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Standard-Pressure, Dry-Pipe / Pre-Action Sprinkler System, 175-psig Maximum Working Pressure:
   1. NPS 1-1/2 and Smaller: Threaded-end, galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
   2. NPS 2: Threaded-end, galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
   3. NPS 2: Grooved-end, galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
   4. NPS 2-1/2 to NPS 3: Threaded-end, galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
   5. NPS 2-1/2 to NPS 3: Grooved-end, galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
   6. NPS 4 to NPS 6: Threaded-end, galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
   7. NPS 4 to NPS 6: Grooved-end, galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints

3.04 STANDPIPE SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Type Standpipe System, 175-psig Maximum Working Pressure:
   1. NPS 4 and Smaller: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
   2. NPS 4 and Smaller: Grooved-end, black or galvanized, standard-weight steel pipe with roll-grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
   3. NPS 5 and NPS 6: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
   4. NPS 5 and NPS 6: Grooved-end, black or galvanized, standard-weight steel pipe with roll-grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints

3.05 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire department connections in vertical wall. Verify exact type, exact location, and style required by local fire department.

B. Install Vertical Post type fire department connection where indicated on Civil Site Utility Plans, Verify exact location and style required by the local fire department. Install with access to buried check valve and drip valve. Install below grade below frost line.

C. Install ball drip valve at each check valve for fire department connection.

D. Provide written verification with submittal that hose threads, type and location are acceptable to the Fire Department and Authority Having Jurisdiction.

3.06 SYSTEM TEST

A. Hydrostatically test entire system in accordance with NFPA 13 for sprinkler systems and NFPA 14 for standpipe systems. Testing of Fire Pump and fire pump accessories shall be in accordance with NFPA 20.

B. Test shall be witnessed by authority having jurisdiction and Owner’s insurance underwriter, or their authorized representatives, and meet all authoritative requirements.

C. All approvals shall be obtained from the proper sources. Contractor’s materials and test certificates for each sprinkler zone and underground piping shall be completed, signed, and delivered to the Owner with one copy delivered to Engineer.

D. Demonstrate the operation of all sprinkler test connections. Demonstration shall take place in the Owners presence. Demonstration shall continue until all system alarms are functioning. Refer to Division 01 Section "Demonstration and Training".

E. The Contractor shall provide all labor, materials, instruments, devices and power required for testing. The test shall be performed in the presence and to the satisfaction of the Engineer/Owners Representative and such other parties as may have legal jurisdiction. No piping in any location shall be closed up, furred in, or covered before testing.

F. Where portions of piping systems is to be covered or concealed before completion of the project, those portions shall be tested separately in the manner specified herein for the respective entire system.

G. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Engineer/Owners Representative shall be retested in part or in whole as directed.

H. Restore to its finished condition any work damaged or disturbed by tests.

I. The equipment shall be tested for stability of support and satisfactory operation. The piping shall be tested when directed by the Engineer/ Owners Representative for stability of support.

J. After the equipment is set and connected, and the piping systems to same have been tested, the contractor shall turn water on, and the proper operation of all items shall be demonstrated

by him in the presence of and to the satisfaction of the Engineer/Owners Representative, fire department, insurance agency or a designated representative.

K. The Contractor shall notify the Owners's Representatives and his inspectors having jurisdiction, a minimum of 48 hours in advance of making any required tests so that arrangements may be made for their presence to witness his scheduled tests.

L. The entire fire suppression system shall be hydrostatically pressure tested for a period of two hours at a pressure of 200 psig except portions of systems normally subjected to working pressure in excess of 150 PSI, shall be tested as described at a pressure of 50 PSI in excess of normal working pressure. During that time the pressure shall not drop. If the pressure does drop, the reason for the drop in pressure shall be identified and corrected. The test will be conducted again until the two-hour test can be completed without pressure drop. The Contractor shall conduct all additional tests required, at no extra cost to the contract bid price.

M. Exterior underground piping shall be tested in accordance with NFPA 13 & 24 Latest Edition.

N. The Contractor shall bleed the air out of all fire department valves and remote test connections so that the pressure test described above is conducted under water pressure and with a minimal amount of air in the system.

3.07 GROUTING

A. Mix and install grout for fire-suppression 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.

3.08 DEMONSTRATION

A. 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. Provide written documentation to Engineer and Owner that this training was completed.

3.09 SYSTEM FLUSHING

A. Engage a factory-authorized service representative to flush sprinkler system. Sprinkler system shall be flushed by using all available test connections and fire department valves. System shall be flushed within thirty days of final acceptance of the fire protection system. Provide written report to Engineer and Owners Representative that the entire fire protection and sprinkler system has been flushed.

3.10 INSTALLATION

A. Design and Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.

B. Design and Install standpipe piping, hangers, and supports in accordance with NFPA 14.

C. Design and install fire pump system in accordance with NFPA 20.

D. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

E. Install piping to conserve building space, to not interfere with use of space and other work.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Install underground ductile-iron service-entrance piping according to NFPA 24 and NFPA 13 with restrained joints.

H. Install ball drip valves to drain piping between fire department connections and check valves. Drain to outside of building.

I. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

J. Pipe Hangers and Supports:
   1. Comply with NFPA 13 for hanger materials.
   2. Install sprinkler system piping according to NFPA 13.
   3. Piping supported with beam clamps shall be attached to the top cord of the structural joists.
   4. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

K. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
   1. Painting of interior fire suppression systems is specified in Section 09 9123.
   2. Painting of exterior fire suppression systems is specified in Section 09 9113.

L. Provide sleeves when penetrating floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
   1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
   2. Underground Service-Entrance Piping: Ductile-iron, mechanical -joint pipe and fittings and restrained joints
   3. 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.
   4. 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.
      a. Install steel pipe for sleeves smaller than 6 inches in diameter.
   5. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
      a. Cut sleeves to length for mounting flush with both surfaces.
         1) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Wet areas shall include but not be limited to Janitor Rooms, pipe chases behind toilet rooms, Mechanical Mezzanine Areas, Kitchen and Laundry Rooms. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
      b. Install sleeves in new walls and slabs as new walls and slabs are constructed.

c. 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:
    1) Steel Pipe Sleeves: For pipes smaller than NPS 6, penetrating concrete masonry wall (CMU)
    2) Steel Sheet Sleeves: For pipes NPS 6 and smaller, penetrating gypsum-board partitions.
    3) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges.
        (a) Seal space outside of sleeve fittings with grout.

6. Aboveground Piping:
    a. Pack solid using mineral fiber complying with ASTM C592.
    b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
7. All Rated Openings: Caulk tight with fire stopping material conforming to {\rs\#1} in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.
8. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.
9. All open pipe ends shall be closed at end of each working day.
10. Coordinate extensions from existing piping systems with new and existing mechanical and electrical systems.
11. 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.
12. Do not use welded joints for galvanized-steel pipe.
13. Install access doors in ceilings of rooms where above ceiling access is required.

M. Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a water-tight seal.
6. Install in accordance with manufacturer's recommendations.

N. Escutcheons:
1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
3. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.

3.11 CLEANING

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

SECTION 21 0553
IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe markers.

D. Ceiling tacks.

1.03 RELATED REQUIREMENTS

A. Section 09 9123 - Interior Painting:

1.04 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems.

B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials.

1.05 SUBMITTALS

A. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Product Data: Provide manufacturers catalog literature for each product required.

D. Manufacturer's Installation Instructions: Indicate special procedures, and installation instructions.

E. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

A. Piping: Tags.

B. Pumps: Nameplates.

C. Valves: Nameplates and ceiling tacks where above lay-in ceilings.

2.02 NAMEPLATES

A. Manufacturers:
   1. Brimar Industries, Inc:
   2. Kolbi Pipe Marker Co.:
   3. Seton Identification Products:
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Description: Laminated three-layer plastic with engraved letters.
   1. Letter Color: White.
   2. Letter Height: 1/4 inch.
   3. Background Color: Red.
   4. Thickness: 1/8 inch.
   5. Plastic: Comply with ASTM D709.

2.03 TAGS

A. Manufacturers:
   1. Advanced Graphic Engraving:
   2. Brady Corporation:
   3. Kolbi Pipe Marker Co.:
   4. Seton Identification Products:
   5. Substitutions: See Section 01 6000 - Product Requirements.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

D. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 PIPE MARKERS

A. Manufacturers:
   1. Brady Corporation:
   2. Brimar Industries, Inc:
   3. Kolbi Pipe Marker Co.:
   4. Seton Identification Products:
   5. Substitutions: See Section 01 6000 - Product Requirements.

B. Color: Comply with ASME A13.1.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

F. Color code as follows:
   1. Fire Quenching Fluids: Red background with white letters.

2.05 CEILING TACKS

A. Manufacturers:
   1. Craftmark:
   2. Seton Identification Products.
   3. Kolbi Pipe Marker Co..
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Description: Steel with 3/4 inch diameter color coded head.

C. Color code as follows:
   1. Piping: White Letters with Red Background.
   2. Sprinkler Valves: White Letters with Red Background.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 9123 for stencil painting.

3.02 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
   1. Where valves are located above removable tile ceilings or above access panels, provide identification nameplates on the corners of the tile or access panels.

B. Install tags with corrosion resistant chain.

C. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

D. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

E. Locate ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

3.03 PAINTING

A. Prepare surfaces in accordance with Section 09 9000 for painting.

B. All exposed fire protection piping in main Mechanical Room and Fire Pump shall be painted

C. All exposed fire protection piping in finished areas and in all stairways shall be painted.

D. All service entrance piping, valves, backflow preventer, and piping serving fire pump shall be painted.

E. Painting shall be the responsibility of the Contractor installing the piping.
   1. Do not paint sprinkler heads.

END OF SECTION

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SECTION 21 1200
FIRE-SUPPRESSION STANDPIPES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Valves.

1.03 RELATED REQUIREMENTS

A. Section 01 4100 - Regulatory Requirements.

B. Section 21 0500 - Common Work Results for Fire Suppression: Fire protection piping.

C. Section 21 1300 - Fire-Suppression Sprinkler Systems.

D. Section 21 3000 - Fire Pumps.

1.04 REFERENCE STANDARDS

A. FM (AG) - FM Approval Guide.

B. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.06 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate supports, components, accessories, and sizes.
   1. Submit shop drawings and product data to Owner's insurance underwriter for approval.

C. Project Record Documents: Record actual locations of components.

D. Operation Data: Include appropriate manufacturer's data.

E. Certificates: Provide certificate of compliance from authority having jurisdiction indicating approval of field acceptance tests.

1.07 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 14. Maintain one copy on site.

1.08 WARRANTY

A. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 VALVES

A. Specialty Valves:

B. Specialty Valves:
   1. Hose Connection Valve: Angle type; brass finish; 2-1/2 inch size, thread to match fire department hardware, 300 psi working pressure, with threaded cap and chain of same material and finish.
   2. Pressure Reducing Valve: Angle type; brass finish with inner hydraulic controls; 1-1/2 inch size, thread to match fire department hardware, 400 psi inlet pressure, with threaded cap and chain of same material and finish.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 14.

C. Connect standpipe system to water source ahead of domestic water connection.

D. Where static pressure exceeds 100 psi at any hose station, provide pressure reducing valve to prevent pressure on hose exceeding 90 psi.

E. Flush entire system of foreign matter.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection and testing (Field Acceptance Test) in accordance with Section 01 4100.

B. Test entire system in accordance with NFPA 14.

C. Test shall be witnessed by Fire Marshal and Authority Having Jurisdiction.

END OF SECTION

SECTION 21 1300
FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wet-pipe sprinkler system.

B. Dry-pipe sprinkler system.

C. System design, installation, and certification.

D. Fire department connections.

E. Sprinkler Pipe Enclosure.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 21 0500 - Common Work Results for Fire Suppression: Pipe and fittings.

C. Section 21 0553 - Identification for Fire Suppression Piping and Equipment.

D. Section 21 1200 - Fire-Suppression Standpipes.

E. Section 21 3000 - Fire Pumps.

F. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

G. Section 28 4600 - Fire Detection and Alarm.

1.03 REFERENCE STANDARDS

A. FM (AG) - FM Approval Guide.

B. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements.

C. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.

D. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

E. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

F. NFPA 13 - Standard for the Installation of Sprinkler Systems.

G. UL (DIR) - Online Certifications Directory.

1.04 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. 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.

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

1.05 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.

B. High-Pressure Piping System Component Working Pressure: Listed for 250 psig minimum.

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

D. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

E. Sprinkler Occupancy Hazard Classifications:
   1. Building Service Areas: Ordinary Hazard, Group 1.
   2. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
   3. General Storage Areas: Ordinary Hazard, Group 1.
   4. Laundries: Ordinary Hazard, Group 1.
   5. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
   6. Office and Public Areas: Light Hazard.
   7. Cells / Dayrooms: Light Hazard.
   8. Restaurant Service Areas: Ordinary Hazard, Group 1.

F. Minimum Density for Automatic-Sprinkler Piping Design:
   1. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
   2. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500 sq. ft.
   3. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
   4. Special Occupancy Hazard: As determined by authorities having jurisdiction.

G. Maximum Protection Area per Sprinkler: Per UL listing.

H. Maximum Protection Area per Sprinkler:
   1. Office Spaces: 225 sq. ft.
   2. Storage Areas: 130 sq. ft.
   3. Mechanical Equipment Rooms: 130 sq. ft.
   4. Electrical Equipment Rooms: 130 sq. ft.
   5. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.

I. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
   1. Light-Hazard Occupancies: 100 gpm for 30 minutes.
   2. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.

J. Future Areas: Sprinkler System shall be hydraulically designed to include all future expansion areas as indicated on the Fire Protection Drawings. Points of connection shall be provided and identified on the Sprinkler Shop Drawings.

1.06 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

C. Shop Drawings:
   1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
   2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
   3. Submit shop drawings and hydraulic calculations to authority having jurisdiction for approval. Submit proof of approval to Architect / Engineer.
   4. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or Model number as specifically published in the appropriate agency listing or approval.
   5. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number, Tyco / Grinnell style or model number or equal Manufacturer as approved by the Engineer.

6. 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" and "Contractor's Material and Test Certificate for Underground Piping."

D. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.

E. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Sprinklers: Type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
   3. Sprinkler Wrenches: For each sprinkler type.

G. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

H. Fire hydrant flow test report.

1.07 QUALITY ASSURANCE

A. The entire installation, including materials, equipment and workmanship shall conform with all applicable laws, codes and regulations of municipal, state and Federal authorities. The 2015 International Building Code, NFPA-13 and other regulatory bodies having jurisdiction over the class of work.

B. Comply with FM (AG) requirements.

C. Designer Qualifications: Preparation of working plans, calculations, and field test reports by a qualified NICET Level IV or greater in Automatic Sprinkler Design or under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

E. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years experience and approved by manufacturer.
   1. Installer's responsibilities include designing, fabricating, and installing fire suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

F. Installer's experience: An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction and who can meet the following qualifications.
   1. Engages on a regular and full time basis in the design and installation of automatic sprinkler systems, with a minimum of five years documented experience.
   2. Employ or contract on a regular basis for system design, a professional engineer, or at least one person having passed the elements for a NICET level IV rating in Automatic Sprinkler Design.
   3. Can provide on-site emergency service within four hours notification.
   4. Meets the requirements of all local and state approving agencies.

G. Equipment and Components: Provide products that bear FM (AG) label or marking.
   1. Where applicable shall bear the stamps or seals of the Factory Mutual Engineering (FM).

H. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

I. 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.

1.08 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, new and existing, including light fixtures, HVAC equipment, bulkhead areas, clouded typed ceilings, and partition assemblies.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sprinklers, Valves, and Equipment:
   1. Tyco Fire Products:
   2. Viking Corporation:
   3. Substitutions: See Section 01 6000 - Product Requirements.

2.02 SPRINKLER SYSTEM

A. Sprinkler System: Provide coverage for entire building.

B. Occupancy and hazard: As indicated on drawings and specified herein.

C. Coverage Type: Standard.
   1. Note:
      a. Extended Coverage sprinklers may be used, provided system meets a minimum 10 Percent safety factor and is approved by local jurisdiction.

D. Water Supply: Determine volume and pressure from existing flow data. If existing design data is over one year old from date of construction of new sprinkler system, the Sprinkler Contractor shall preform actual water flow test in accordance with NFPA 13.

E. Interface system with building fire and smoke alarm system.

F. Provide fire department connections .

G. Storage Cabinet for Spare Sprinklers and Tools: Steel, .

H. Pipe Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
   1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
   2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
   3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
   4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
   5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
   6. Other Types: As required.
   7. Manufacturers:
      a. AFCON, a brand of Anvil International: www.anvilintl.com/#sle.
      b. Powers Fasteners, Inc:
      c. Hilti.
      d. Substitutions: See Section 01 6000 - Product Requirements.

2.03 SPRINKLERS

A. Suspended Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.
   1. Response Type: Quick.

2. Coverage Type: Standard.
3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
4. Product:
    a. Tyco Fire Products-Model TY-FRL
    b. Viking Microfast® Model M
    c. Victaulic Model V27
5. Drawing identification Tag "P"

B. Suspended Ceiling Type: Concealed type with cover plate.
1. Response Type: Quick.
2. Coverage Type: Standard.
3. Finish: Enamel, color White .
4. Fusible Link: Glass bulb type temperature rated for specific area hazard.
5. Product:
    a. Tyco Fire Products - Model RFII
    b. Viking Model “Horizon®, Mirage®, Quasar”
    c. Victaulic Model V38
    d. Substitutions: See Section 01 6000 - Product Requirements.
6. Drawing identification Tag "C"

C. Exposed Area Type: Pendant type with guard.
1. Response Type: Quick.
2. Coverage Type: Standard or Extended.
3. Finish: Brass.
4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
5. Product:
    a. Tyco Fire Products-Model TY-FRB
    b. Viking Microfast®
    c. Victaulic Model V27
6. Drawing identification Tag "U".

D. Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
1. Response Type: Quick.
2. Coverage Type: Standard or Extended.
3. Finish: Brass.
4. Escutcheon Plate Finish: Brass.
5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
6. Product:
    a. Tyco Fire Products-Model TY-FRL
    b. Viking Microfast®
    c. Victaulic Model V27
7. Drawing identification Tag "SW".

E. Dry Sprinklers: Concealed pendant type with matching push on escutcheon plate.
1. Response Type: Quick.
2. Coverage Type: Standard.
3. Finish: Brass.
4. Cover Plate Finish: Brass.
5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
6. Product:
    a. Tyco Fire Products-Model DS-1
    b. Viking Model M

c. Victaulic Model V36 adjustable recessed or adjustable standard.

7. Drawing identification Tag "DP".
   a. Refrigerators, freezers, and areas subject to freezing.

F. Institutional Sprinklers:
   1. Sidewall:
      a. Type: Sidewall with conical shape escutcheon plate, and retaining flange. Tag “S.”
      b. Fusible Link: Solder link/vandal resistant.
      c. Finish: Sprinkler - polish chrome; Escutcheon Plate - chrome.
      d. Model: “Raven”, for holding cells, sidewall institutional quick response, standard or extended coverage as manufactured by Tyco.
   2. Pendent
      a. Type: Pendent with lock ring, escutcheon plate, and retaining flange. Tag “A.”
      b. Fusible Link: Solder Link/vandal resistant.
      c. Finish: Sprinkler - polish chrome; Escutcheon Plate - chrome.
      d. Model “Raven, institutional quick response, standard or extended coverage as manufactured by Tyco.
   3. Areas Requiring Sprinkler Pipe Enclosure: Ceiling or sidewall institutional automatic spray nozzle, as manufactured by Tyco or equal approved by the Engineer, Quick Response or Standard Response, with solder link.
   4. Install retainer flange for installation on all individual institutional sprinklers to prevent any axial movement.
   5. Areas outside of holding rooms and cell areas, accessible to inmates: Institution solder link sprinklers as manufactured by Reliable, Tyco or Viking.

G. Extensions: Drawing identification Tag "E.”
   1. For installation in all areas with surface mounted lighting fixtures.
   2. Product:
      a. Tyco Fire Products - Style 401 2-piece escutcheon.

H. Protection: All sprinklers shall be provided with factory-supplied protective cover to protect installed sprinklers during construction.

I. Flexible Drop System:
   1. Application: Use to properly locate sprinkler heads.
   2. Include all supports and bracing.
   3. Provide braided type tube as required for the application.
   4. Description: In lieu of rigid pipe offsets or return bends for sprinkler drops, the Victaulic AquaFlex® stainless steel sprinkler fitting system may be used to locate sprinklers as required by final finished ceiling tiles and walls. The drop system shall consist of a braided or upbraided (corrugated) Type 304 stainless steel flexible tube, a zinc plated steel 1" NPT male threaded nipple for connection to branch-line piping, and a zinc plated steel reducer with a 1/2" or 3/4" NPT female thread for connection to the sprinkler head. The flexible drop must be listed for a minimum of three 90 degree bends to assure proper installation. Union joints shall be provided for ease of installation. The flexible drop shall attach to the ceiling grid using a one-piece open gate bracket (the bracket shall allow for sprinkler installation before or after the bracket is secured to the sprinkler grid). The braided drop system is FM approved for sprinkler services to 200 psi and can be installed without the use of tools, and the corrugated system is UL listed for sprinkler services to 175 psi. All hoses shall be factory-pressure tested to 400 psi.
   5. Manufacturers:
      a. FlexHead Industries, a brand of Anvil International: www.anvilintl.com/#sle.
      b. Victaulic Victaulic AquaFlex®
      c. Substitutions: See Section 01 6000 - Product Requirements.

J. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

K. Sprinklers shall have 250-psig minimum pressure rating if sprinklers are components of high-pressure piping system.

2.04 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: UL 193, designed for vertical or horizontal installation, with bronze grooved seat with Nitrile O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, external water motor alarm, pressure gages, retarding chamber, exterior water motor alarm and fill-line attachment with strainer. Valve internal components shall be replaceable without removing the valve from the installed position.
   1. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
   2. Activate electric alarm.
   3. Product:
      a. Tyco Fire Products - Model AV-1-300
      b. Victaulic Company; Series 751 with Series 760 motor alarm: www.victaulic.com.
      c. Victaulic Company FireLock® Series 751, Viking Easy Riser or approved equal.
      d. Substitutions: See Section 01 6000 - Product Requirements.

B. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
   1. Activate electric alarm.
   2. Test and drain valve.
   3. Replaceable internal components without removing valve from installed position.
   4. Manufacturers:
      a. Victaulic Company; Series 751 with Series 760 motor alarm: www.victaulic.com/#sle.

C. Dry Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm, accelerator, and with the following additional capabilities and features:
   1. Activate electric alarm.
   2. Test and drain valve.
   3. Externally resettable.
   4. Replaceable internal components without removing valve from installed position.
   5. Manufacturers:
      a. Victaulic Company; Series 768 - NXT: www.victaulic.com/#sle.

D. Backflow Preventer: Double check valve assembly backflow preventer with drain and OS & Y gate valve on each end.

E. Test Connections:
   1. Inspector's Test Connection for Sprinkler Systems:
      a. Provide test connections approximately 6 ft above floor for each sprinkler system equipped with an alarm device, located at the most remote part of each system.
      b. Route test connection to an open-site drain location, excluding janitor sinks, accepting full flow without negative consequences.
      c. Supply discharge orifice with same size as corresponding sprinkler orifice.
      d. Limit vertical height of exterior wall penetration to 2 ft above finished grade.
   2. Manufacturers:
      a. Tyco Fire Products - Model F350: Sectional Test & Drain.
      b. Victaulic
      c. Viking Corp.

F. Electric Alarm: Electrically operated chrome plated gong with pressure alarm switch.

G. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.

H. Sprinkler Specialty Fittings: Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.
   1. Outlet Specialty Fittings:
   2. Manufacturers:
      a. Anvil International, Inc.
      b. Shurjoint Piping Products, Inc.
      c. Victaulic Co. of America.
   3. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron, or bronze body; with threaded or grooved inlet and outlet, test valve, and orifice and sight glass.
      a. Manufacturers:
         1) Tyco Fire Products - Model F350: Sectional Test & Drain
         2) Viking Corp.
         3) Victaulic Co. of America. Victaulic Style 720 TestMaster II™.
   4. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
      a. Manufacturers:
         1) Elkhart Brass Mfg. Co., Inc.
         2) Fire-End and Croker Corp.
         3) Potter-Roemer; Fire-Protection Div.
   5. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
      a. Manufacturers:
         1) AGF Manufacturing Co.
         2) G/J Innovations, Inc.
         3) Triple R Specialty of Ajax, Inc.
   6. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.
      a. Manufacturers:
         1) CECA, LLC.
         2) Merit.

2.05 SPRINKLER PIPE COVER

A. Manufacturers:
   1. Soffi-Steel™ Systems, by Grice Engineering, Inc., Janesville, WI, 1-800-800-3213.
   2. Substitutions: See Section 01 6000 - Product Requirements.

B. Enclosures: 16 gauge stainless steel with interfacing clips to render cover non-removable once installed. Size to accommodate the specific pipe system.

C. Location:
   1. Install in all areas where piping is accessible to inmates.
   2. In areas where shown on the Drawings

2.06 AIR COMPRESSOR

A. Compressor: Single-unit, electric motor driven, motor, motor starter, safety valves, check valves, air maintenance device incorporating electric pressure switch and unloader valve.o

B. Provide at each dry sprinkler system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with referenced NFPA design and installation standard.

B. Install equipment in accordance with manufacturer's instructions.

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

D. Install sprinkler piping with drains for system drainage in accordance of NFPA 13.

E. Provide a drain at base of risers, drain connection on valved sections, and drain at other locations for drainage of the system to meet NFPA requirements. Provide valve in drain lines and connect to the drain riser. Discharge riser outside over splash block, or as indicated. The main drain shall be capable of full discharge test without allowing water to flow onto the floor.

F. Install buried shut-off valves in valve box. Provide post indicator.

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

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

I. Provide approved double detector check valve assembly at sprinkler system water source connection.

J. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.

K. Locate outside alarm gong on building wall as indicated.

L. Place pipe runs to minimize obstruction to other work.

M. Place piping in concealed spaces above finished ceilings.

N. The Sprinkler Contractor shall carefully investigate all conditions affecting his work with other trades to prevent interference between Architectural, Structural, Electrical, and other Mechanical features.
   1. All sprinkler piping shall be installed above ceilings, except as noted on the drawings. Sprinkler piping which cannot be installed above ceilings because of structural conditions shall be coordinated with the Architect and Owner.

O. Center sprinklers in center of ceiling tile and provide piping offsets as required..

P. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.

Q. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.

R. Flexible Sprinkler Connection Installation:
   1. Install flexible hose assemblies, ceiling attachments in accordance with manufacturers written instructions.
   2. All braided stainless steel flexible; hose assemblies shall have a minimum bend radius of 7” or specified otherwise herein.
   3. AquaFlex® Series AQB braided stainless steel flexible hose assembly shall have a minimum bend radius of 7” (and Series AQU upbraided stainless steel flexible hose

assembly shall have a minimum bend radius of 4”).

S. Install and connect to fire pump system in accordance with Section 21 3000.

T. Flush entire piping system of foreign matter.

U. Hydrostatically test entire system.

V. Require tests shall be witnessed by authority having jurisdiction.

W. Install sprinkler cover in accordance with manufacturer's written instructions.

X. Sprinkler piping identification: Refer to Section 21 0553 "Identification for Fire Suppression Piping and equipment".

3.02 SPRINKLER APPLICATIONS

A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:

B. Rooms without Ceilings: Upright sprinklers.

C. Rooms with Suspended Ceilings: Recessed sprinklers.

D. Wall Mounting: Sidewall sprinklers.

E. Spaces Subject to Freezing: Upright, pendent, dry type sprinklers; and sidewall, dry sprinklers as indicated.

F. Sprinkler Finishes:
   1. Upright, Pendent, and Sidewall 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.
   2. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
   3. Flush Sprinklers: Bright white, with painted white escutcheon.

G. Recessed Sprinklers: Bright white, with bright white escutcheon.

3.03 INTERFACE WITH OTHER PRODUCTS

A. Ensure required devices are installed and connected as required to fire alarm system.

3.04 RECORD DRAWING DOCUMENTATION

A. Provide a mylar as-built drawing and two copies shall be provided for each drawing. One copy of final CADD drawing files shall also be provided on compact diskette for each drawing.

B. Provide four sets of manufacturer’s literature and data updated to include submittal review comments and any equipment substitutions.

C. Provide four sets of hydraulic calculations for each sprinkler system updated to include submittal review comments and any changes to the installation that affect the calculations and changes made during construction.

D. Provide four copies of operation and maintenance data updated to include submittal review comments and any substitutions.

E. Provide manufacturer's literature, hydraulic calculations, reports, and operation and maintenance data in a labeled three-ring binder.

3.05 WARRANTY AND MAINTENANCE

A. All work performed and materials and equipment furnished under this Contract shall be free from defects for a period of one year from acceptance by the Owner.

B. A factory trained authorized representative of the sprinkler system installer shall provide complete maintenance and quarterly inspection service for each sprinkler system for a period of one year. Maintenance and testing shall be performed on a quarterly basis, beginning after final acceptance of the system by the Owner.

3.06 COMMISSIONING

A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.

B. Verify that specified test of piping are complete.

C. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.

D. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.

E. Verify that sprinkler protective cap has been removed.

F. Verify that potable-water supplies have correct types of backflow preventers.

G. Verify that hose connections and fire department connections have threads compatible with local fire department equipment.

H. Fill wet-pipe sprinkler piping with water.

I. Verify that hose connections are correct type and size.

J. Energize circuits to electrical equipment and devices.

K. Adjust operating controls and pressure settings.

END OF SECTION

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SECTION 21 3000
FIRE PUMPS

PART 1 GENERAL

1.01 RELATD DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Fire pump package, including fire pump, electric motor drive, controller, and accessories.

B. Electric Pressure Maintenance Pump, jockey pump.

C. System maintenance.

1.03 RELATED REQUIREMENTS

A. Section 21 0500 - Common Work Results for Fire Suppression: Fire protection piping.

B. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.04 REFERENCE STANDARDS

A. FM (AG) - FM Approval Guide.

B. NEMA MG 1 - Motors and Generators.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. NFPA 13 - Standard for the Installation of Sprinkler Systems.

E. NFPA 20 - Standard for the Installation of Stationary Pumps for Fire Protection.

F. UL (DIR) - Online Certifications Directory.

G. UL 448 - Centrifugal Stationary Pumps for Fire-Protection Service.

H. UL 778 - Standard for Motor-Operated Water Pumps.

I. UL 1478 - Fire Pump Relief Valves.

1.05 SUBMITTALS

A. Product Data: Provide manufacturers literature including general assembly, pump curves showing performance characteristics with pump and system, operating point indicated, NPSH curve, controls, wiring diagrams, and service connections.

B. Shop Drawings: Indicate layout, general assembly, components, dimensions, weights, clearances, and methods of assembly.

C. Test Reports: Indicate results of hydrostatic test and field acceptance tests.

D. Manufacturer's Instructions: Indicate support details, connection requirements, for fire pump system.

E. Designer's Qualification Statement.

F. Manufacturer's Qualification Statement.

G. Installer's Qualification Statement.

H. Maintenance Contract.

I. Operation Data: Include manufacturers instructions, start-up data, trouble-shooting check lists, for pumps, drivers, and controllers.

J. Maintenance Data: Include manufacturers literature, cleaning procedures, replacement parts lists, and repair data for pumps, drivers and controllers.

K. Project Record Documents: Record actual locations of components and accessories.

L. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 13 and NFPA 20; where requirements differ comply with the most stringent.

B. Maintain on site at all times one copy of each design and installation standard referenced.

C. Designer Qualifications: Design fire pump system, preparation of working plans, calculations and field test reports by a qualified NICET Level V or greater in Automatic Sprinkler Design or under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
   1. Note: Fire pump and Jockey pump pressure boost and horse power requirements shall be reviewed and revised, if necessary, after water flow test is performed on new fire hydrant adjacent to the building site. Coordinate electrical revisions with the Electrical Contractor.

D. Equipment and Components: Bearing FM (AG) label or marking.

E. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

F. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years experience.

G. Provide certificate of compliance from authority have jurisdiction indicating approval of field acceptance tests.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver fire pumps and components in factory packing. Comply with manufacturer's rigging and installation instructions.

B. Provide temporary inlet and outlet caps, and maintain in place until installation.

1.08 COORDINATION

A. Coordinate size and location of concrete bases for the package fire pump system.

B. Coordinate location of fire service water piping and backflow preventer location to comply with the fire pump suction piping requirements.

PART 2 PRODUCTS

2.01 FIRE PUMP SYSTEM

A. Manufacturers:
   1. AC Fire Pump, a xylem brand: www.acfirepump.com/#sle.
   2. Patterson Pump Company, a Gorman-Rupp Company: www.pattersonpumps.com/#sle.
   3. Peerless Pump Company: www.peerlesspump.com/#sle.

B. Fire Pumps: Vertical in-line type; UL 448 and UL 778; single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 250 psi.
   1. Casing: Cast or ductile iron, with suction and discharge gauge port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
   2. Impeller: Bronze, fully enclosed, keyed directly to motor shaft.
   3. Shaft: Solid alloy steel with bronze sleeve.
   4. Seal: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 230 degrees F maximum continuous operating temperature.
   5. Seal: Carbon rotating against a stationary ceramic seat viton fitted, 225 degrees F maximum continuous operating temperature.
   6. Performance: Refer to Fire Protection Drawings for flow, feet of head and electrical characteristics.

7. Fire Pump shall be a packaged fire pump system, with all components mounted on a skid, including fire pump, jockey pump, transfer switch, fire pump and jockey pump controller.

C. Accessories:
   1. Eccentric suction reducer and OS&Y gate or butterfly valve on suction side of pump.
   2. Concentric increaser and check valve in pump discharge and OS&Y gate or butterfly valve on system side of check valve.
   3. Fire pump bypass fitted with OS&Y gate or butterfly valves and check valve.
   4. Main relief valve, UL 1478 and enclosed type waste cone.
   5. Suction pressure gauge, 4-1/2 inch diameter dial with snubber, valve cock and lever handle.
   6. Discharge pressure gauge mounted on board attached to pump, with snubber, valve cock and lever handle.
   7. 3/4 inch casing relief valve.
   8. Float operated 3/4 inch automatic air release valve.
   9. Flow metering system for closed loop testing.
   10. Test-header Manifold: Ductile-iron or bras body for hose valves with cap and chains. Include nozzle outlets arranged in single line; horizontal, flush-wall polished chrome plated with lettering equivalent to "PUMP TEST CONNECTION".

2.02 ELECTRIC MOTOR DRIVE:

A. Motor: Squirrel cage induction type, NEMA MG 1; in open drip proof NEMA 250 enclosure, 3500 rpm. The motor shall be suitable for wye-delta open transition reduced voltage type.

B. Controller: Limited service type with auto-transformer starter, in NEMA 250 enclosure, including the following:
   1. The controller shall be provided by the manufacturer as a packaged unit.
   2. The fire pump controller and transfer switch shall be a single factory wired unit meeting the requirements of the most recently mandated edition of NFPA 20 and shall be listed by Underwriters Laboratories, Inc., and approved by Factory Mutual Research Corporation.
   3. Rate controller for scheduled fire-pump horsepower and short-circuit withstand rating at least equal to short-circuit current available at controller location. Take into account cable size and distance from substation or supply transformers.
   4. Disconnect Switch: Externally operable, quick break type.
   5. Circuit Breaker: Comply with NFPA 20; minimum 65,000 amperes interrupting capacity.
   6. Motor Starter: Energized automatically through pressure switch or manually by externally operable handle.
   7. Running Period Timer: Keeps motor in operation when started automatically, for a minimum of seven minutes.
   8. The power transfer switch shall be designated for use with generator set emergency power source.
   9. The power transfer switch shall include a motor rated disconnect / isolating switch capable of interrupting the motor locked rotor current. The disconnect / isolating switch shall be mechanically interlocked so that the enclosure door cannot be opened with the handle in the ON position except by a hidden tool operated defeater mechanism.
   10. The transfer switch circuitry shall be capable of sensing both the normal power source and the emergency source. The normal power source pickup shall be set to pickup at 90 percent nominal voltage and 95 percent nominal frequency. All voltage sensing, frequency sensing, and time delays shall be field adjustable. The transfer signal shall be delayed for one second, delaying the transfer and engine start signals so as to override momentary normal power outages.
   11. The transfer switch shall have TRANSFER SWITCH NORMAL, TRANSFER SWITCH EMERGENCY, and EMERGENCY ISOLATING SWITCH OFF, pilot lights, TEST nd TRANSFER BYPASS switches, audible alarm, and SILENCE ALARM pushbutton

mounted on the flange of the enclosure

2.03 PRESSURE BOOSTER (JOCKEY) PUMP

A. Manufacturers:
   1. Armstrong Pumps Inc: www.armstrongpumps.com/#sle.
   2. Grundfos: www.us.grundfos.com/#sle.
   3. Substitutions: See Section 01 6000 - Product Requirements.

B. Electrically operated, horizontal turbine type with standard open drip-proof horizontal motor.

C. Control by automatic jockey pump controller with full voltage starter and minimum run timer to start pump on pressure drop in system and stay in operation for minimum period of time. Fire pump shall start automatically on further pressure drop or on jockey pump failure.

D. 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.
   6. Control circuit transformer, 120v control voltage.

E. Accessories and Specialties: Match pressure-maintenance-pump suction and discharge ratings as required for pump capacity rating. Include the following:
   1. Circulation relief valve.
   2. Suction and discharge pressure gages.

F. Performance and Electrical Characteristics: Refer to Drawings.

2.04 ALARM PANELS

A. Description: Factory-assembled and wired remote panel complying with UL 508 and requirements in NFPA 20. Include audible and visible alarms matching controller type.
   1. Manufacturers:
      a. Cutler-Hammer
      b. Firetrol, Inc.
      c. Hubbell Industrial Controls, Inc.
      d. Metron, Inc.
   2. Enclosure: NEMA 250, Type 2, remote wall mounting type.
      a. Finish: Manufacturer's standard red paint applied to factory-assembled and tested unit before shipping.
   3. Features: Include manufacturer's standard features and the following:
      a. Motor operating condition
      b. Loss of line power
      c. Phase reversal
      d. Low water alarm

2.05 FACTORY FABRICATION

A. All equipment shall be completed and tested at the factory and shall be mounted on an open structural steel skid.

B. Equipment mounted on the skid shall include:
   1. Fire Pump
   2. Fire Pump Controller
   3. Jockey Pump
   4. Jockey Pump Controller
   5. Alarm Panels

6. All other associated fire pump accessories, except as noted in paragraph below.

C. Items not skid mounted:
   1. Test Header
   2. Hose Valves
   3. Fire Department Connection

D. The entire package shall require three power connections.
   1. Main normal power to main fire pump controller.
   2. Emergency power to transfer switch.
   3. Pressure-maintenance (jockey pump) controller.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with NFPA 20.

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

C. Provide access space around pumps for service; no less than minimum as recommended by manufacturer.

D. Install pressure gages on fire pump suction and discharge at pressure gage tappings.

E. Provide full size valved by-pass piping around fire pump

F. Install piping in accordance with Section 21 0500. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For base mounted pumps, provide supports under elbows on pump suction and discharge.

G. Provide drains for bases and seals, piped to and discharging into floor drains.

H. Provide for connection to electrical service. Refer to Section 26 0583.

I. All wiring from the automatic transfer switch to emergency generator shall be by the fire pump installer. Coordinate all wiring with the Electrical Contractor.

J. Provide tamper switches on all control valves serving the fire pump.

K. Lubricate pumps before start-up.

L. Check, align, and certify pumps by qualified installer prior to start-up.

M. Locate the remote Alarm Panel in the main Vestibule, or as directed by the Local Fire Department.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 4000 - Quality Requirements.

B. Perform hydrostatic tests, flushing, and field acceptance tests as specified in NFPA 20. Additionally; the entire package system shall be hydrostatically tested by the system manufacturer prior to shipment.

C. Perform field acceptance tests in the presence of Fire Marshal.

D. 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. Perform start-up and Acceptance tests in accordance with NFPA. Report results in writing with a copy to Owner, Engineer and Construction Manager.
   1. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Fire hoses are fora field-

acceptance test only and are not property of the Owner.

3.03 CLOSEOUT ACTIVITIES

A. Demonstrate automatic operation of system including verification of pressure switch set points to Owner.

B. Use operation and maintenance data as reference during demonstration.

C. Briefly describe function, operation, and maintenance of each component.

D. Conduct walking tour of project.

E. Training: Train Owner's personnel on operation and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.
   3. Instructor: Manufacturer's training personnel.
   4. Location: At project site.

3.04 MAINTENANCE

A. Provide service and maintenance of equipment installed under this section for one year from the Date of Substantial Completion. Maintenance and testing shall be performed quarterly.

B. The Sprinkler Service Contractor may perform maintenance only if certified and recommended by the fire pump manufacturer to perform maintenance on the fire pump. Maintenance performance shall be conducted in accordance with all local codes, Owner's Insurance Underwriter and to meet the requirements of Authority having Jurisdiction.

END OF SECTION

SECTION 22 0500
COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Piping materials and installation instructions common to most piping systems.

B. Transition fittings

C. Dielectric fittings

D. Escutcheons

E. Grout

F. Equipment installation requirements common to equipment sections

G. Painting and finishing

H. Concrete bases

I. Supports and anchorages

1.03 RELATED REQUIREMENTS

A. Section 01 4000 - Quality Control Requirements: Procedures for testing, inspection, mock-ups, reports, certificates; use of reference standards.

B. Section 01 8100 - Commissioning Requirements.

1.04 ABBREVIATIONS AND ACRONYMS

A. 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

B. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber
   2. NBR: Acrylonitrile-butadiene rubber

1.05 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.

1.06 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. Refer to individual specification sections.

1.07 QUALITY ASSURANCE

A. Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience.

D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

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

F. 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."

G. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

H. All components used in the domestic water system shall be lead free and shall conform to the safe drinking water act, as amended 01-04-2011 Section 1417.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.09 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.

D. Coordinate installation of plumbing systems with all other Trades.

E. Coordinate mock-up of penal all cell and shower pipe chases

F. Coordinate installation of plumbing systems with the Pre-Cast Cell Manufacturer.

G. All holes in pre-cast concrete panels and planks shall be performed in accordance with the pre-cast manufacturers written instructions and recommendations.

1.10 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Refer to individual specification sections for additional warranty requirements.

PART 2 PRODUCTS

2.01 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. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

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

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

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

2.02 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.

B. Manufacturers:
   1. Cascade Waterworks Mfg. Co.
   2. Dresser Industries, Inc.; DMD Div.
   3. JCM Industries.
   4. Smith-Blair, Inc.
   5. Viking Johnson.

C. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.

D. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.

E. Aboveground Pressure Piping: Pipe fitting.

F. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Available Manufacturers:
      a. Eslon Thermoplastics.

G. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Available Manufacturers:
      a. Thompson Plastics, Inc.

H. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Available Manufacturers:
      a. NIBCO INC.

b. NIBCO, Inc.; Chemtrol Div.

I. 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.
   1. Manufacturers:
      a. Fernco, Inc.
      b. Husky, Corona, CA.
      c. Mission Rubber Company

2.03 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 degrees F.
   1. Available Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Watts Industries, Inc.; Water Products Div.
      d. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   1. Available Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Available Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.
   2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig 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 degrees F.
   1. Available Manufacturers:
      a. Calpico, Inc.
      b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 degrees F.
   1. Available Manufacturers:
      a. Perfection Corp.
      b. Precision Plumbing Products, Inc.
      c. Sioux Chief Manufacturing Co., Inc.
      d. Victaulic Co. of America.

2.04 ESCUTCHEONS

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

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

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.

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

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

2.05 GROUT

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

B. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, non gaseous, and recommended for interior and exterior applications.

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

D. Packaging: Premixed and factory packaged.

2.06 SECURITY METAL FASTENERS

A. Refer to Division 5 Section “Security Metal Fasteners”.

PART 3 EXECUTION

3.01 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.
   1. Provide 2-inch clearance between insulated piping and other obstructions.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet and hinge.
      g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
      h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
   2. Existing Piping: Use the following:
      a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
      b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and spring clips.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
      d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
      e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
      f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
      g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Verify final equipment locations for roughing-in.

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

3.02 PIPE 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. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators.

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

3.03 PIPING CONNECTIONS

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

B. Install unions, in piping NPS 2 and smaller, at final connection to each piece of equipment.

C. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

D. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

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

3.04 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.

E. Install plumbing equipment in accordance with manufacturers written instructions.

F. Install water heaters and pressure vessels with required minimum state and local codes space requirements.

G. Install pressure relief valves in all pressure vessels to comply with all State and Local code requirements.

3.05 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections Painting and Division 22 Sections.

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

3.06 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."

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

B. Field Welding: Comply with AWS D1.

3.08 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.

3.09 VISIT TO SITE

A. Prior to submission of bid, visit site and become familiar with existing conditions. Bids, as submitted, will be interpreted to include all costs and changes made necessary by existing conditions.

B. Verify, in field, the size, the location and elevation of all underground services affected by this work before proceeding with construction. Notify the Owners's Representative immediately in the event the location of existing utilities vary appreciably from those shown on Drawings.

3.10 RECORD DRAWINGS

A. Record Drawing shall indicate all valves with valve tag numbers noted on Drawings.

B. Ceiling access panels for all plumbing valves, cleanouts, traps, and other items of the plumbing system that require maintenance shall be shown on the Record Drawings.

3.11 ACCESS DOORS

A. Access doors furnished under this Contract must be compatible with the system in which they are to be installed including applicable ratings. In addition, access doors must be sized to allow for use of normal maintenance using normal tools and equipment.

B. This Contractor shall provide minimum 14 gauge stainless steel access panels for access to the rear connection and for maintenance of all rear-mounted security fixtures where access in not provided. Size shall be as indicated on the Drawings.

C. Refer to Division 08 Section "Access Doors and Panels".

3.12 COMMISSIONING

A. See Section 01 8100 for commissioning requirements.

B. Perform the following Functional Tests:
   1. Domestic water booster systems.
   2. Domestic water heaters.
   3. Elevator sump pumps
   4. Balancing valves
   5. Master Thermostatic Mixing Valves

6. Water cooler temperature and flow height.
7. Plumbing fixture flow rates.

3.13 CLOSEOUT ACTIVITIES

A. Demonstrate proper operation of equipment to Owner's designated representative.

B. Demonstration: Demonstrate operation of system to Owner's personnel.
1. Use operation and maintenance data as reference during demonstration.
2. Conduct walking tour of project.
3. Briefly describe function, operation, and maintenance of each component.

C. Training: Train Owner's personnel on operation and maintenance of system.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Manufacturer's training personnel.
4. Location: At project site.

3.14 PROTECTION

A. Protect installed plumbing fixtures and equipment from subsequent construction operations.

END OF SECTION

SECTION 22 0516
EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Flexible pipe connectors.

B. Expansion joints and compensators.

C. Pipe loops, offsets, and swing joints.

1.03 RELATED REQUIREMENTS

A. Section 22 1005 - Plumbing Piping.

1.04 REFERENCE STANDARDS

A. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

B. EJMA (STDS) - EJMA Standards.

1.05 SUBMITTALS

A. Product Data:
   1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.

B. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.

C. Maintenance Data: Include adjustment instructions.

D. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Packing for Packed Expansion Joints: One set for each joint.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

A. Manufacturers:
   1. Mercer Rubber Company
   2. The Metraflex Company
   3. Flex-Hose

B. Inner Hose: Carbon steel.

C. Exterior Sleeve: Single braided, stainless steel.

D. Pressure Rating: 125 psi and 450 degrees F.

E. Joint: Flanged.

F. Size: Use pipe sized units.

G. Maximum offset: 3/4 inch on each side of installed center line.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

A. Manufacturers:
   1. Mercer Rubber Company
   2. The Metraflex Company

B. Inner Hose: Bronze.

C. Exterior Sleeve: Braided bronze.

D. Pressure Rating: 125 psi and 450 degrees F.

E. Joint: Flanged.

F. Size: Use pipe sized units.

G. Maximum offset: 3/4 inch on each side of installed center line.

H. Application: Copper piping.

2.03 EXPANSION JOINTS AND LOOPS - HOSE AND BRAID

A. Manufacturers:
   1. The Metraflex Company; Metraloop: www.metraflex.com/#sle.
   2. Flex-Hose.

B. Provide flexible loops with two flexible sections of hose and braid, two 90 degree elbows, and 180 degree return with support bracket and air release or drain plug.

C. Provide flexible loops capable of movement in the x, y, and z planes. Flexible loops to impart no thrust loads to the building structure.

D. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
   1. Maximum Allowable Working Pressure: 150 psig at 120 degrees F.
   2. Accommodate the Following:
      a. Axial Deflection in Compression and Expansion: 1 inch.
      b. Lateral Movement: 1 inch.
      c. Angular Rotation: 15 degrees.
      d. Force developed by 1.5 times specified maximum allowable operating pressure.
   3. End Connections: Same as specified for pipe jointing.
   4. Provide necessary accessories including, but not limited to, swivel joints.

2.04 ACCESSORIES

A. Stainless Steel Pipe: ASTM A269/A269M, seamless type, Grade TP304.

B. Pipe Alignment Guides:
   1. Manufacturers:
      a. The Metraflex Company; PGQ Glide Riser Guide: www.metraflex.com/#sle.
      b. Substitutions: See Section 01 6000 - Product Requirements.
   2. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.

C. Swivel Joints:
   1. Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.

C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.

D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

E. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.

F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

G. Provide pre-manufactured Tri-Flex stainless steel expansion systems at all building expansion joints and where indicated on the drawings.

H. Expansion loops with guides and anchors shall be installed on all domestic hot water supply and return piping systems greater than 100 feet in straight length, unless indicated otherwise on the drawings.

I. Swing connections:
   1. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
   2. Connect riser and branch connections to terminal units with at least four pipe fittings, including tee in riser.
   3. Connect branch connections that occur between guides and loop with at least three pipe fittings including tee in main.

END OF SECTION

SECTION 22 0517
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe sleeves.

B. Manufactured sleeve-seal systems.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 22 0553 - Common Work Results For Plumbing.

C. Section 22 0523 - General-Duty Valves for Plumbing Piping.

D. Section 22 0553 - Identification for Plumbing Piping and Equipment: Piping identification.

E. Section 22 0719 - Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS

A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).

B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified this section.
   1. Minimum three years experience.
   2. Approved by manufacturer.

C. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.

B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a 1 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

A. Manufacturers:
   1. Flexicraft Industries
   2. Substitutions: See Section 01 6000 - Product Requirements.

B. Vertical Piping:
   1. Sleeve Length: 1 inch above finished floor.
   2. Provide sealant for watertight joint.
   3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
   4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

C. Steel or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.

D. Pipe Passing Through Below Grade Exterior Walls:
   1. Zinc coated or cast iron pipe.
   2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.

E. Pipe Passing Through Concrete Beam Flanges, except where Brass Pipe Sleeves are Specified:
   1. Galvanized steel pipe or black iron pipe with asphalt coating.
   2. Connect sleeve with floor plate except in mechanical rooms.

F. Pipe Passing Through Mechanical, Laundry, Food Service Areas similar type rooms and Floors above:
   1. Galvanized steel pipe or black iron pipe with asphalt coating.
   2. Connect sleeve with floor plate except in mechanical rooms.

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

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

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

J. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

K. PVC Pipe: ASTM D 1785, Schedule 40.

L. Clearances:
   1. Provide allowance for insulated piping.
   2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
   3. All Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.02 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Manufacturers:
   1. Flexicraft Industries;
   2. Link Seal.
   3. Metraflex Co..
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Modular/Mechanical Seal:
   1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
   2. Provide watertight seal between pipe and wall/casing opening.
   3. Elastomer element size and material in accordance with manufacturer's recommendations.
   4. Glass reinforced plastic pressure end plates.

5. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
6. Pressure Plates: Plastic, Carbon steel, stainless steel, or glass reinforced nylon polymer. Include two for each sealing element.
7. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

C. 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.
a. Required on all through-roof piping systems.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

B. Install piping to conserve building space, to not interfere with use of space and other work.

C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

D. Inserts:
1. Provide inserts for placement in concrete formwork.
2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

E. Structural Considerations:
1. Do not penetrate building structural members unless indicated.

F. Provide sleeves when penetrating or passing through footings, concrete and masonry walls, gypsum-board partitions, concrete floor and roof slabs. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
1. Cut sleeves to length for horizontal mounting flush with both surfaces.
2. Cut sleeves for vertical installation 1 inch above finished floor and 1 inch extended on lower end of sleeve.
a. Exception: Extend sleeves installed in floors of mechanical equipment areas, mechanical equipment rooms, pipe chases, or other wet areas 2 inches above finished floor level. Wet areas shall be identified as the main Kitchen or Food Service Areas, Laundry areas, Janitor rooms . Waterproof area between sleeve and structure. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring.
3. Install sleeves in new walls and slabs as new walls and slabs are constructed.
4. 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 6 inch.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

c. Galvanized Sleeves, schedule 40: For all size pipes in foundation walls and under footings. Sleeves shall be two pipe size larger than pipe.
d. 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.

5. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
   a. Pipe sleeve shall be two pipe sizes larger than carrier pipe. Refer to details on Structural Drawings.
6. Aboveground Piping:
   a. Pack solid using mineral fiber complying with ASTM C592.
   b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
7. All Rated Openings / Fire Barrier Penetrations: Caulk tight with fire stopping material conforming to ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases. Maintain indicated fire rating of walls, partitions, ceilings and floors. Refer to Division 7 for firestopping materials.
8. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.

G. Sleeves are not required for core-drilled holes.
   1. Bare piping passing through masonry shall not contact masonry and be protected with approved covering.

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

I. 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.

J. 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.

K. Manufactured Sleeve-Seal Systems:
   1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
   2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
   3. Locate piping in center of sleeve or penetration.
   4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
   5. Tighten bolting for a water-tight seal.
   6. Install in accordance with manufacturer's recommendations.

L. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

M. Provide escutcheons at pipe sleeves exposed in finished areas.

3.03 CLEANING

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

SECTION 22 0519
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pressure gauges and pressure gauge taps.

B. Thermometers and thermometer wells.

C. Water Meter.

D. Static pressure gauges.

1.02 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments.

B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers.

C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

C. Project Record Documents: Record actual locations of components and instrumentation.

1.04 FIELD CONDITIONS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

A. Manufacturers:
   1. Ashcroft Commercial Instrument Operations.
   2. Dwyer Instruments, Inc:
   3. Mash Bellofram.
   4. Moeller Instrument Co., Inc:
   5. Omega Engineering, Inc.
   6. Trerice, H.O. Co.

B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background. Indicating-dial type.
   1. Case: Liquid-filled type, drawn steel or cast aluminum, 4-1/2-inch diameter.
   2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
   3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
   4. Movement: Mechanical, with link to pressure element and connection to pointer.
   5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
   6. Pointer: Red or other dark-color metal.
   7. Window: Glass.
   8. Ring: Metal, brass, or stainless steel.
   9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
   10. Range for Fluids under Pressure: Two times operating pressure.

11. Gas pressure gauges shall be suitable for measuring extreme low pressure in inches of water column.
    a. Trerice Model 760 or equal as approved by the Engineer.

2.02 PRESSURE GAUGE TAPPINGS

A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.

B. Needle Valve: Stainless steel or Brass, 1/4 inch NPT for minimum 150 psi.

C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

D. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.

2.03 STEM TYPE THERMOMETERS

A. Manufacturers:
1. Ashcroft Commercial Instrument Operations.
2. Dwyer Instruments, Inc:
3. Marsh Bellofram.
4. Omega Engineering, Inc:
5. Trerice Model BX-9
6. Weksler Glass Thermometer Corp:

B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
1. Size: 9 inch scale.
2. Window: Clear Lexan.
3. Stem: 3/4 inch NPT brass.
4. Accuracy: 2 percent, per ASTM E77.
5. Calibration: Degrees F.

2.04 DIAL THERMOMETERS

A. Manufacturers:
1. Dwyer Instruments, Inc:
2. Omega Engineering, Inc:
3. Weksler Glass Thermometer Corp:
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Thermometers - Fixed Mounting: Dial type bimetallic actuated; ASTM E1; stainless steel case, silicone fluid damping, white with black markings and black pointer, hermetically sealed lens, stainless steel stem.
1. Size: 5 inch diameter dial.
2. Lens: Clear glass.
3. Accuracy: 1 percent.
4. Calibration: Degrees F.

2.05 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
1. Product: Trerice, H.O. Co. (Model 3-4F2) or approved equal.

2.06 TEST PLUGS

A. Manufactures:
1. Texas Fairfax, Inc.
2. Peterson Equipment Co., Inc. Pete's Plug II.

3. Sisco Manufacturing Co.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 degrees F.

D. Core Inserts: One or two self-sealing rubber valves.
   1. Insert material for water service at 20 to 200 degrees F shall be CR.
   2. Insert material for water service at minus 30 to plus 275 degrees F shall be EPDM.

E. Test Kit: Furnish one test kit, containing one pressure gage and adaptor, two thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
   1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
   2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 160 degrees F.

2.07 WATER METER

A. Manufacturers:
   1. Senus

B. Type: Exact type as required by the local Water Department.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide instruments with scale ranges selected according to service with largest appropriate scale.

C. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

D. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

E. Locate test plugs adjacent thermometers and thermometer sockets.

F. Install thermowell with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.

G. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

H. Install needle-valve and snubber fitting in piping for each pressure gage.

I. Install test plugs in tees in piping.

J. Install thermometers and gages adjacent to equipment to allow service and maintenance for thermometers, gages, and equipment.

3.02 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers at outlet of all temperature control valves, each domestic hot-water storage tank.

B. Install liquid-in-glass thermometers at hot water recirculation balancing valves.

C. Install liquid-in-glass thermometers where indicated on the Drawings.

D. Install liquid-filled-case-type or bimetallic-actuated dial thermometers at suction and discharge of each pump.

E. Install dial thermometers on pressure vessels where indicated.

F. Provide the following temperature ranges for thermometers:
   1. Domestic Hot Water: 30 to 240 degrees F, with 2-degrees scale divisions.
   2. Domestic Cold Water: 0 to 160 degrees F, with 2-degree scale divisions.

3.03 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install liquid-filled case-type pressure gages at suction and discharge of each pump, at building water service entrance and where indicated on Drawings.
   1. Exception: Do not install pressure gages at domestic water hot water return pumps.

C. Install liquid-filled case-type pressure gages at building water service entrance. Install gages before and after the building's backflow preventer.

D. Install liquid-filled case-type pressure gages where indicated on the drawings.

3.04 WATER METER INSTALLATION

A. Install in accordance with Water Authority requirements.

END OF SECTION

SECTION 22 0523
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Applications.
B. General requirements.
C. Ball valves.
D. Butterfly valves.
E. Balancing valves
F. Check valves.
G. Gate valves.
H. Globe valves.
I. Plug valves.
J. Interior water service valves
K. Drain valves

1.03 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.
B. Section 08 3100 - Access Doors and Panels.
C. Section 22 0553 - Identification for Plumbing Piping and Equipment.
D. Section 22 0716 - Plumbing Equipment Insulation.
E. Section 22 0719 - Plumbing Piping Insulation.
F. Section 22 1005 - Plumbing Piping.

1.04 ABBREVIATIONS AND ACRONYMS

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

1.05 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

C. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard.

D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves.

E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

F. ASME B16.34 - Valves - Flanged, Threaded and Welding End.

G. ASME B31.9 - Building Services Piping.

H. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fuzing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications.

I. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

J. ASTM A536 - Standard Specification for Ductile Iron Castings.

K. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

L. AWWA C606 - Grooved and Shouldered Joints.

M. MSS SP-67 - Butterfly Valves.

N. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.

O. NSF 61 - Drinking Water System Components - Health Effects.

P. NSF 372 - Drinking Water System Components - Lead Content.

1.06 SUBMITTALS

A. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

B. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

D. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

1.07 QUALITY ASSURANCE

A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.
   2. Company must specialize in manufacturing products specified in this section, with not less than seven years of documented experience.
   3. Manufacturer's name and pressure rating marked on valve body.
   4. Comply with "Buy American Act".
   5. Maximum Zinc content 15% all bronze valves.
   6. Extended Valve Stems: Provide on all ball valves installed on insulated piping.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
   2. Protect valve parts exposed to piped medium against rust and corrosion.
   3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.

4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
5. Secure check valves in either the closed position or open position.
6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:
1. Maintain valve end protection and protect flanges and specialties from dirt.
a. Provide temporary inlet and outlet caps.
b. Maintain caps in place until installation.
2. Store valves in shipping containers and maintain in place until installation.
a. Store valves indoors in dry environment.
b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. See drawings for specific valve locations.

B. Provide the following valves for the applications if not indicated on drawings:
1. Shutoff. Ball, gate, butterfly.
2. Dead-End: Single-flange butterfly (lug) type.
3. Throttling: Provide globe. Design calibrated type.

C. Install unions downstream of valves that are connected to equipment or apparatus connections.

D. Provide flow controls in water recirculating systems where indicated

E. Domestic Water Piping: Use the following types of "lead free" valves:
1. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy, full port.
2. Ball Valves, NPS 2-1/2: Three-piece, 600 psig CWP rating, copper alloy, full port.
3. Butterfly Valves, NPS 3 and Larger: Lug style, 200-psig CWP rating.
4. Grooved-End, Ductile-Iron Butterfly Valves, NPS 3 and Larger: 300-psig CWP rating.

F. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
1. All water system valves shall be suitable for 200 psig minimum working pressure at 250 degrees F, unless indicted otherwise.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
1. Handwheel: Valves other than quarter-turn types.
2. Hand Lever: Quarter-turn valves 6 NPS and smaller except plug valves.
3. Wrench: Plug valves with square heads.

D. Valves in Insulated Piping: With 2 NPS stem extensions and the following features:
1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

E. Valve-End Connections:
1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5.
4. Solder Joint Connections: ASME B16.18.

5. Grooved End Connections: AWWA C606.

F. General ASME Compliance:
   1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
   2. Solder-joint Connections: ASME B16.18.
   3. Building Services Piping Valves: ASME B31.9.

G. Valve Materials for Potable Water: NSF 61 and NSF 372.

H. Bronze Valves:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.

I. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRONZE BALL VALVES

A. Manufacturers:
   1. Conbraco Industries / Apollo Valves:
   2. Nibco, Inc:
   3. Milwaukee Valve Company:

B. 2-inch and smaller: Two-Piece, Full Port, Copper-Alloy, Lead-Free Ball Valves, blowout-proof stem, Stainless Steel Trim, Vented Ball. 600-psig minimum CWP. Extended handle for insulated pipe.
   1. Nibco Model T/S 585-66-LF-(NS) w/Nib Seal. For Press: PC-585-66-LF-(NS) Nib Seal
   2. Apollo Series 77 CLF / 77 WLF Series w/Thermoseal Handle for T/S. 77WF with Thermoseal handle for Press.
   3. Milwaukee Valve Company

C. 2-1/2-inch: Three-Piece, Full Port, Copper-Alloy Lead Free Ball Valves, blowout-proof stem, Stainless Steel Trim, Vented Ball. 600-psig minimum CWP. Extended handle for insulated pipe.
   1. Nibco Model T/S 595-Y-66-LF-(NS) w/Nib Seal.
   2. Apollo 82LF Series
   3. Milwaukee Valve Company

D. 2-1/2 inch: Two-Piece, Full Port, Copper-Alloy Lead Free Ball Valves blowout-proof stem, Stainless Steel Trim. 600-psig minimum CWP. Extended handle for insulated pipe.
   1. Apollo:77CLF20904 T/S w/2-1/4" stem extension. 77VLF2090 Press w/2-1/2" stem extension.

E. Insulated Valve Stems: Where piping is insulated, ball valves shall be equipped with 2-inch extended handles of non-thermal conductive material. Provide a protective sleeve that allows for operation of the valve without breaking the vapor seal or disturbing the insulation.

F. Lead Free Identification: Valve shall be provided with visual lead free marking, color coated white handle and blue hang tag to distinguish between valves not meeting "Lead Free".

2.04 BUTTERFLY VALVES

A. Lug type: Bi-directional dead-end service without use of downstream flange.

B. Manufacturers:
   1. Grinnell Mechanical Products, a Tyco International Co
   2. Tyco Flow Control:
   3. Milwaukee Valve Company:
   4. Nibco Model LD 2000-3-BFV

C. Full-Lug Style, Lead Free, 200-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Lug type with ductile iron body, full lug style with 2-inch extended neck for installation, bronze/aluminum alloy disc without use of exposed stem fasteners, stainless steel, one-piece stem extended

completely through disc, with EPDM "O" ring seal and sleeve type bearings contained in both valve body hubs, EPDM valve seats permanently molded to valve body, with zero leakage at 200 psig (3 inch-12 inch) differential pressure. Valves shall be capable to provide dead-end service at “full rated pressure-of the valve” without the need for a downstream flange. EPDM shall be rated A -20 degree to +250 degree temperature. Provide lever lock handles and plate, (3 inch-6 inch) Nibco Model LD-2000-3-BFV. Gear operator (over 6-inch).

D. Grooved-End, 300-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Ductile-iron or steel body with grooved or shouldered ends, Elastomer Encapsulated Disc EPDM or Buna Material with a MAX temp rating of 200 degrees F with 416 SS stem. Lever Operator (3 inch-4 inch) Gear Operator (6 inch and larger).
   1. Comply with MSS SP-67, Type I.
   2. CWP Rating: 200 psig.
   3. Body: ASTM A126, cast iron or ASTM A536, ductile iron.
   4. Stem: One or two-piece stainless steel.
   5. Seat: EPDM.
   6. Disc: Coated ductile iron.

2.05 BALANCING VALVES / FLOW CONTROLS

A. Manufacturers: Copper-Alloy Calibrated Balancing Valves: "Lead Free"
   1. Xylem, Bell & Gossett: Circuit Setter
      a. Type: Globe valve design valve with two readout ports and memory setting indicator, integral check valve and cap.
      b. Body: Brass or bronze with dezincification - resistant
      c. Size: Same as connected piping, but not larger than NPS 2.
   2. Nibco: T/S 1810LF
      a. Type: Multi-Turn oblique globe type.
      b. Body: Brass or bronze with dezincification - resistant. Valve body shall be fitted with a fixed orifice venturi for flow measurement and two-external test ports (PT ports) to measure upstream and downstream pressure across the venturi. Flow accuracy shall be at +/- 5% between the full open position (100%) and 25% open.
      c. Size: Same as connected piping, unless indicted other otherwise.
      d. Operation: Valves shall be provided with a multi-turn handwheel which shall incorporate a position indicator showing full turns and 1/10th turn. Full open to full close shall require at least 4 handwheel turns. A memory stop adjustable over the full valve travel shall be provided in the valve stem.
   3. Accessories:
      a. One (1) Meter hoses, fittings, valves, differential pressure meter, and carrying case for each system containing more than three (3) balancing valve stations.
   4. Memory-Stop Balancing Valves:
      a. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
      b. Pressure Rating: 400-psig minimum CWP.
      c. Size: NPS 2 or smaller.
      d. Body: Copper alloy.
      e. Port: Standard or full port.
      f. Ball: Chrome-plated brass.
      g. Seats and Seals: Replaceable.
      h. End Connections: Solder joint or threaded.
      i. Handle: Vinyl-covered steel with memory-setting device.

2.06 BRONZE SWING CHECK VALVES

A. Manufacturers:
   1. Conbraco Industries / Apollo Valves

2. Milwaukee Valve Company
3. Nibco, Inc.

B. Up to 2 Inches:
1. MSS SP-80, Class 125, bronze body and cap, bronze swing disc with rubber seat, solder or threaded ends.
a. Nibco Model: T/S-413-Y-LF
b. Apollo Model: 163S-LF
c. Milwaukee Valve Company

C. Over 2 Inches:
1. MSS SP-71, Class 125, iron body, bronze swing disc, renewable disc seal and seat, flanged or grooved ends.
a. Nibco Model: F-910-LF
b. Apollo
c. Milwaukee Valve Company

2.07 BRONZE GATE VALVES

A. Non-Rising Stem (NRS) or Rising Stem (RS):
1. Comply with MSS SP-80, Type I.
2. Class 125: CWP Rating: 200 psig:.
3. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
4. Ends: Threaded or solder joint joint.
5. Stem: Bronze.
6. Disc: Solid wedge; bronze.
7. Packing: Asbestos free.
8. Handwheel: Malleable iron or bronze.
9. Manufacturers:
a. Conbraco Industries / Apollo Valves.
b. Milwaukee Valve Company
c. Nibco, Inc.

2.08 BRONZE GLOBE VALVES

A. Class 125: CWP Rating: 200 psig: and Class 150: CWP Rating: 300 psig:.
1. Comply with MSS SP-80, Type 1.
2. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
3. Ends: Threaded joint.
4. Stem: Bronze.
5. Disc: PTFE.
6. Packing: Asbestos free.
7. Handwheel: Malleable Iron.
8. Manufacturers:
a. Conbraco Industries / Apollo Valves.
b. Milwaukee Valve Company
c. Nibco, Inc

2.09 INTERIOR WATER SERVICE VALVES

A. Gate valves at interior service, 2-1/2" and larger shall be Lead Free. Raised Face Flanges, Bolted Bonnet, Outside Screw and Yoke, Solid Wedge, 316 Stainless steel trim. 250 PSI Non-Shock Working Pressure to 100° F

B. Manufacturers:
1. Apollo 6Q Series, ductile iron flanged ball.
2. Nibco Model F-637-33.

3. Milwaukee Valve Company

2.10 DRAIN VALVES

A. Ball-Valve Type, Hose-End Drain Valve HEBV-1:
   1. Manufacturers:
      a. Nibco. Model S-585-66-LF-HC
      b. Apollo
      c. Milwaukee Valve company
   2. Standard: MSS-110 for full-port two-piece ball valves.
   3. Pressure Rating: 400 psig minimum.
   4. Size NPS 3/4 or as indicated on drawings.
   5. Handle: Vinyl-covered steel.
   6. Inlet: Threaded or solder joint.
   7. Outlet: Threaded, short nipple with garden-hose thread, vacuum breaker, and cap with brass chain.

PART 3 EXECUTION

3.01 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. Should valve be determined to be defective, replace with new valve.

3.02 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

D. Install check valves where necessary to maintain direction of flow as follows:
   1. Lift Check: Install with stem plumb and vertical.
   2. Swing Check: Install horizontal maintaining hinge pin level.
   3. Orient plate-type into horizontal or vertical position, between flanges.

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

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

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

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

I. Where piping is insulated, ball valves shall be equipped with 2-inch extended handle of non-thermal conductive material, provided with a protective sleeve that allows operation of the valve without breaking seal or disturbing the insulation.

J. Provide access doors in ceiling and walls where valves are not exposed. Access doors shall be of appropriate size, but not less than 24-inches by 24-inches square. Access doors to valves in pipe chases may be smaller provided sufficient room is provided to reach and control the valve. The Plumbing Contractor shall determine exact size and locations. Size shall be sufficient to

allow installation of service. Access doors shall be located in a symmetrical appearance, coordinated with other trades. Refer to Division 08 Section "Access Doors and Panels".

K. All valves located above suspended ceilings, shall be installed no higher than thirty inches above the ceiling. Piping shall be lower as necessary to accommodate the location of valves.

L. Access doors to plumbing valves shall be indicated on the Record Drawings.

M. Valves shall be identified on Record Drawings with appropriate valve identification numbers. Valve identification shall also include description of what valve serves.

N. Install ball valves for shut-off and isolating service, to isolate equipment, part of systems or vertical risers where service requires valve to be wide open or tightly closed. All ball valves on insulated piping systems shall have extended valve handles to accommodate insulation thickness.

O. Provide drain valves at main shut-off valves, low point of piping system. Entire piping system shall be able to be drained.

P. Provide valve tags, ceiling identification labels and directory chart.

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

R. Install check valve and balancing valve on hot water recirculation piping.

S. Balancing Valves: Provide certified balance report to Architect/Engineer indicating all hot water recirculating balancing valves have been adjusted and set to meet the gpm flow as noted on the Drawings.

END OF SECTION

SECTION 22 0529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Support and attachment components for equipment, piping, and other plumbing work.

1.03 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.

1.04 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping.

D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.

E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.

F. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

H. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

I. MFMA-4 - Metal Framing Standards Publication.

J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

1.07 QUALITY ASSURANCE

A. Comply with applicable building code.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, or specified in other Division 22 sections, select in accordance with manufacturer's application criteria as required for the load to be supported 2.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Metal Channel (Strut) Framing Systems:
   1. Manufacturers:
      a. Cooper B-Line, a division of Eaton Corporation :www.cooperindustries.com/#sle.
      b. Substitutions: See Section 01 6000 - Product Requirements.
      c. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
   2. Comply with MFMA-4.

C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
   1. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports: 1/2 inch diameter.
      b. Piping up to 1 inch (27 mm) nominal: 1/4 inch diameter.
      c. Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter.
      d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.

D. Thermal Insulated Pipe Supports:
   1. Manufacturers:
      a. Buckaroos, Inc: www.buckaroos.com/#sle.
   2. General Construction and Requirements:
      a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
      b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
      c. Pipe supports to be provided for nominally sized, 1/2 inch to 30 inch iron pipes.

d. Insulation inserts to consist of rigid phenolic foam insulation surrounded by a 360 degree, PVC jacketing.

3. PVC Jacket:
   a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
   b. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
   c. Thickness: 60 mil.
4. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

E. Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.
1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

F. Riser Clamps:
1. Provide copper plated clamps for copper tubing support.
2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.

G. Pipe Hangers: For a given pipe run, use hangers of the same type and material.
1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
2. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.

H. Intermediate Pipe Guides: Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.
1. Manufacturers:
   a. Anvil International: www.anvilintl.com/#sle.
   b. Substitutions: See Section 01 6000 - Product Requirements.
   c. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
2. Pipe Diameter 6 inches and Smaller: Provide minimum clearance of 0.16 inch.
3. Pipe Diameter 8 inches: Provide U-bolts with double nuts providing minimum clearance of 0.28 inch.
4. Pipe Diameter 8 inches: 0.625 inch U-bolt.

I. Pipe Alignment Guides: Galvanized steel.
1. Manufacturers:
   a. Anvil International: www.anvilintl.com/#sle.
   b. Substitutions: See Section 01 6000 - Product Requirements.
   c. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
2. Pipe Diameter 8 inches and Smaller: Spider or sleeve type.

J. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

K. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
1. Manufacturers:
   a. Anvil International; H-Block: www.anvilintl.com/#sle.
   b. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
   c. Erico International Corporation, a brand of Pentair: www.erico.com/#sle.
   d. Ferguson Enterprises Inc: www.fnw.com/#sle.

e. PHP Systems/Design: www.phpsd.com/#sle.
f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

2. Provide steel pedestals with thermoplastic or rubber base that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
3. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
5. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

L. Pipe Shields for Insulated Piping:
1. Manufacturers:
a. Anvil International: www.anvilintl.com/#sle.
b. Substitutions: See Section 01 6000 - Product Requirements.
c. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
2. General Construction and Requirements:
a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
b. Shields Material: UV-resistant polypropylene with glass fill.
c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
d. Minimum Service Temperature: Minus 40 degrees F.
e. Maximum Service Temperature: 178 degrees F.
f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

M. Anchors and Fasteners:
1. Manufacturers - Mechanical Anchors:
a. Hilti, Inc: www.us.hilti.com/#sle.
b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
c. Powers Fasteners, Inc: www.powers.com/#sle.
2. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
3. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
4. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
5. Hollow Masonry: Use toggle bolts.
6. Hollow Stud Walls: Use toggle bolts.
7. Steel: Use beam clamps, machine bolts, or welded threaded studs.
8. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
a. Comply with MFMA-4.
b. Channel Material: Use galvanized steel.
c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

N. Pipe Installation Accessories:
1. PEX Pipe Supports:
a. Manufacturers:
1) HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

G. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.

I. Secure fasteners according to manufacturer's recommended torque settings.

J. Remove temporary supports.

3.02 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe markers.

D. Ceiling tacks.

1.03 RELATED REQUIREMENTS

A. Section 09 9123 - Interior Painting: Identification painting.

1.04 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems.

B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials.

1.05 SUBMITTALS

A. List: Submit list of wording, symbols, letter size, and color coding for mechanical and plumbing identification.

B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Product Data: Provide manufacturers catalog literature for each product required.

D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

E. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

A. Piping: Pipe markers

B. Pumps: Nameplates.

C. Small-sized Equipment: Tags.

D. Tanks: Nameplates.

E. Valves: Tags and ceiling tacks where located above lay-in ceiling.

F. Water Treatment Devices: Nameplates.

G. Water Heaters: Nameplates.

H. Backflow Devices: Tags

I. Specialties: Tags

2.02 NAMEPLATES

A. Manufacturers:
   1. Brimar Industries, Inc.
   2. Kolbi Pipe Marker Co.
   3. Seton Identification Products

B. Description: Laminated three-layer plastic with engraved letters.
   1. Letter Color: White.
   2. Letter Height: 1/4 inch.
   3. Background Color: Black.
   4. Plastic: Comply with ASTM D709.
   5. Fasteners: Stainless-steel rivets or self-tapping screws.
   6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
   7. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

2.03 TAGS

A. Manufacturers:
   1. Advanced Graphic Engraving
   2. Brady Corporation
   3. Brimar Industries, Inc.
   4. Kolbi Pipe Marker Co.
   5. Seton Identification Products

B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.
   1. Valve-tag schedule shall be included in operation and maintenance data.
   2. 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.

2.04 PIPE MARKERS

A. Manufacturers:
   1. Brady Corporation
   2. Brimar Industries, Inc
   3. Kolbi Pipe Marker Co
   4. Seton Identification Products

B. Comply with ASME A13.1.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

F. Color code as follows:
   1. Potable, Cooling, Boiler, Feed, Other Water: Green with white letters.
   2. Domestic Hot Water and Return: Yellow with black letters
   3. Fire Quenching Fluids: Red with white letters.
   4. Flammable Fluids: Yellow with black letters.
   5. Compressed Air: Blue with white letters.
   6. Sanitary DWV, Plumbing Traps, and Storm Drainage Piping: Green with white letters.
   7. Natural Gas: Yellow with black letters

2.05 CEILING TACKS

A. Manufacturers:
   1. Craftmark
   2. Brady Co.
   3. Bunting, Inc

B. Description: Steel with 3/4 inch diameter color coded head.

C. Color code as follows:
   1. Plumbing Valves: Green.
   2. Plumbing traps and cleanouts: Green.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

D. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
   1. Underground gas piping: Install minimum 10 gage insulated tracer wire, 4 to 6 inches above the underground service line

E. Use tags on piping 3/4 inch diameter and smaller.

F. Pipe Label Installation:
   1. Identify service, flow direction, and pressure.
   2. Install in clear view and align with axis of piping.
   3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
   4. Pipes with OD, including insulation less than 6:
      a. Pretensioned pipe markers. Use size to insure a tight fit.
   5. Pipes with OD, including insulation 6 inches and larger:
      a. Shaped pipe markers. Use size to match pipe and secure with fasteners.

G. Nameplate Installation:
   1. Where valves, cleanouts, traps, etc., are located above removable tile ceilings or above access panels, provide identification labels on the corners of the tile or access panels. Nameplate shall be secured with screws or rivets or adhesive as recommended by the manufacturer.

H. Equipment Label Installation:
   1. Install on each major item of plumbing equipment.
   2. Locate equipment labels where accessible and visible.
   3. Name plate shall include all specific data, such as model number, serial number, motor data, horsepower, sizes, capacities, flows, working pressures, and similar factors as applicable. Pumps shall include head in feet and impeller sizes. The Contractor shall be responsible for furnishing and installing the identification plate if not provided by the equipment manufacturer.

a. Water Heaters
b. Storage tanks
c. Pumps
d. In-line Circulators
e. Balancing Valve Stations
f. Master Tempering Control Valves
g. Elevator Sump Pump Control Panel.
h. Water Meter
i. Backflow Preventer
j. Domestic Water Booster Systems

4. Record Drawings
   a. Identify all main and branch valve tags on Record Drawings.
   b. Identify all plumbing access doors and cleanout panels on Record Drawings.

END OF SECTION

SECTION 22 0719
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Piping insulation. hwdo.

B. Jackets and accessories.

1.03 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 07 8413 - Penetration Firestopping.

C. Section 09 9123 - Interior Painting: Painting insulation jacket.

D. Section 22 1005 - Plumbing Piping: Placement of hangers and hanger inserts.

1.04 REFERENCE STANDARDS

A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

D. ASTM C335 - Standard Test Method For Steady - State Heat Transfer Properties of Pipe insulation.

E. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.

F. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

G. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.

H. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.

I. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

J. ASTM D1056 - Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.

K. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.

L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

M. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

N. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.05 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

C. Detail insulation application at pipe expansion joints for each type of insulation.

D. Samples and mock-ups of systems shall be provided upon Engineer's request.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 3 years of experience.

C. 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.

D. Fire-Test-Response Characteristics: Insulation and related materials shall be UL Classified per UL 723 or meeting ASTM E 84, as determined by testing identical products mounted and installed as per ASTM E 2231. All testing shall be performed by a testing and inspecting agency acceptable to authorities having jurisdiction. Insulation, jacket materials, adhesives, mastics, tapes and cement material containers shall be labeled with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

E. Supply glass mineral wool products that have achieved UL Environment GREENGUARD GOLD Certification and are verified formaldehyde free per 3 rd Party Certification with UL Environmental Validation.

F. Biosoluble: As determined by research conducted by the International Agency for Research on Cancer (IARC) and supported by revised reports from the National Toxicology Program (NTP) and the California Office of Environmental Health Hazard Assessment. Certified by European Certification Board for Mineral Wool Products (EUCEB).

G. Recycled Content: A minimum of 50% recycled glass content certified and UL Validated.

H. Low Emitting Materials: For all thermal and acoustical applications of Glass Mineral Wool Insulation Products, provide materials complying with the testing and products requirements of UL Environment GREENGUARD Gold certification.

I. Living Building Challenge-Declare, Red List Free whenever possible.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.08 DEFINITIONS

A. ASJ: All Service Jacket.

B. ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a draft paper interleaving with an outer film layer leaving no paper exposed.

C. SSL: Self-Sealing Lap.

D. SSL+: Self-Sealing Advanced Closure System.

E. PCV: Polyvinyl Chloride.

F. Thermal Conductivity (K value): Btu•in./hr.•ft²•°F

G. UL Classified: UL has tested and evaluated samples of the product with respect to certain properties of the product. UL classifies products to - applicable UL requirements, standards for

safety and standards of other National and International organizations.
1. The testing and evaluation process is an on-going process; rather than a one-time test.

H. UL Environment GREENGUARD provides independent, third-party, Indoor Air Quality (IAQ) certification of products for emissions of respirable particles and Volatile Organic Compounds (VOCs), including formaldehyde and other specific product-related pollutants.
1. Certification is based upon criteria used by EPA, OSHA and WHO.

I. EPA: Environmental Protection Agency.

J. WHO: World Health Organization.

K. FSK: Foil Scrim Kraft; jacketing.

L. PSK: Poly Scrim Kraft; jacketing.

M. Glass Mineral Wool: Interchangeable with fiber glass.

N. ECOSE Technology: a revolutionary new binder system based on rapidly renewable bio-based materials; rather than petroleum-based chemicals commonly used in other glass wool insulation materials.
1. ECOSE Technology reduces the binder embodied energy by up to 70% and does not contain phenol, formaldehyde, acrylics or artificial colors.

O. UL GREENGUARD GOLD Certification: (formerly known as GREENGUARD Children & Schools Certification) offers stricter certification criteria, considers safety factors to account for sensitive individuals (such as children and the elderly), and ensures that a product is acceptable for use in environments such as schools and healthcare facilities.
1. It is referenced by both The Collaborative for High Performance Schools (CHPS) and the Leadership in Energy Environmental Design (LEED) Building Rating Systems.

P. UL Environment Formaldehyde Free Verification Requirements:
1. For a product to be verified as formaldehyde free, product samples must have a measured emission factor of less than or equal to 5 $\mu g/m^2h$ at 24 elapsed hours or 3 $\mu g/m^2h$ at 336 elapsed hours. An emission factor of 5 $\mu g/m^2h$ corresponds to measured chamber concentration of 2.5 $\mu g/m^3$ for a typical building ratio of 0.5 m^2/m^3. This chamber concentration is comparable to, or below typical outdoor air concentrations. This demonstrates that the formaldehyde exposure from products labeled as formaldehyde free will not contribute to airborne formaldehyde concentrations at greater levels than those found in the natural outdoor environment.

Q. Declare and The Living Building Challenge: The Living Building Challenge is a philosophy, advocacy tool and certification program that addresses development at all scales.
1. The purpose of The Living Building Challenge is to define the most advanced measure of sustainability in the built environment today and acts to diminish the gap between current limits and ideal solutions. Declare supports The Living Building Challenge by providing a transparent materials database that project teams can select from to meet Imperative 11.

R. Imperative 11, Red List: requires that manufacturers disclose the ingredients in their products to insure that they are free of Red List chemicals and materials.
1. The Red List represents the “worst in class” materials, chemicals and elements known to pose serious risks to human health and the greater ecosystem.

S. Underwriter’s Laboratories Environment (UL Environment): offers independent green claims validation, product assessment and certification. UL GREENGUARD provides third-party credibility for sustainable products

T. UL Environment Claims Validation (ECV):
1. Service and label tests a manufacturer’s product and validates that the environmental claims they make in their marketing and packaging materials are factual. This ECV service will allow manufacturers to verify that their products contain a quantifiable amount of

recycled content and, as such, help limit raw material extraction and reduce landfill waste. It also will enable products to qualify for LEED points under Pilot Credit 43: MR - Certified Products.

U. EUCEB: exonerated fiber from a health and safety standpoint by the European Certification Board process

V. Recycled Content - Post-Consumer: materials such as bottled glass collected at curbside or other collection sites after consumer use and used in the manufacturing process to create a new product; rather than being placed in a landfill or incinerated

W. Recycled Content - Pre-Consumer: aka post-industrial, materials used or created from one manufacturing process which are collected as scrap and placed back into another manufacturing process; rather than being placed in a landfill or incinerated

X. Polybrominated Diphenyl Ethers (PBDE) such as Penta-BDE, Octa-BDE or Deca-BDE fire retardants: have been linked to adverse health effects after exposure in low concentrations

1.09 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

C. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested and UL Classified in accordance with UL 723, or meeting ASTM E84, and NFPA 255.

2.02 GLASS MINERAL WOOL

A. Manufacturers:
   1. Knauf Insulation:Earthwool 1000° Pipe Insulation with ECOSE Technology ASJ+ ;
      a. Earthwool Redi-Klad 1000° Pipe Insulation with ECOSE Technology: (exposed non return air plenum areas.
   2. Owens Corning Corporation; VaporWick Pipe Insulation: www.ocbuildingspec.com/#sle.
      a. PVC Jacket in exposed non return air plenum areas.

B. Insulation: ASTM C547; Type I and Type IV, Grade A; ASTM C585; ASTM C411 and ASTM C795; rigid molded, noncombustible.
   1. K Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 850 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.
   4. Living Building Challenge – Declare, Red List Free for Redi-Klad Pipe and unjacketed Earthwool Pipe.

C. Vapor Retarder Jacket: ASJ +/ SSL+ conforming to ASTM C 1136 Type I,II, III, IV,& VIII secured with self-sealing longitudinal laps and matching ASJ+ butt Strips.
   1. Perm rating per ASTM E96 .02 perms or less.

D. Redi-Klad Jacket: Venture Clad 5-ply weather and abuse resistant with self-seal lap. Zero permeability per ASTM E 96-05; puncture resistance per ASTM D 1000; tear strength 4.3 lb per ASTM D 624; thickness 0.0145 inch, 4.5 mil; tensile strength 68.0 lb/inch width

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
   1. Manufacturers:
      a. Substitutions: See Section 01 6000 - Product Requirements.

F. Insulating Cement: ASTM C449.

2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
   1. Aeroflex USA, Inc
   2. Armacell LLC
   3. K-Flex USA LLC

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 300 degrees F.
   3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
   1. Adhesive shall be the insulation manufacturer's recommended contact adhesive.

D. Tapes: Sealing tape to be 20-mil EPDM rubber with acrylic adhesive equal to Aerocel Prota tape.

E. Accessories: adhesives, mastics and cements shall not detract from any of the system ratings as specified.

F. Hanger assemblies: Insulation shall be installed as a system, using insulated hanger assemblies as specifically designed for Flexible Elastomeric Cellular insulating systems.
   1. Insulation system shall include hermetic 3-piece assembly system: insulation, crush-resistant pipe-hanger inserts, and self-adhesive moisture tape.

G. Insulated Pipe Saddles:
   1. Insulated pipe saddles shall be high-density insulation with an inner lining of EPDM rubber insulating tape and an EPDM rubber exterior jacket: Aerocel Aerofix Pipe Hanger Inserts.
   2. Density of insulation is to be a minimum 14 lbs/ cu.ft., with a compressive strength of 284 P.S.I. or greater, and a k-value of .312 or lower, usage temperature range of -297 degree F to 257 degree F, water absorption of 5% or less. Exterior jacket is be be 20-mil thick EPDM rubber.

H. Limitations:
   1. Option to use only within CMU construction walls and trap primer piping systems.

2.04 HANGER SADDLES

A. Manufacturers:
   1. AeroFlix
   2. Klo Shure
   3. Buckaroo,Inc.

B. Description:180 degree arc design, center partial rib on bottom of saddle, designed to secure saddle inside the clevis hanger properly and to prevent saddle from sliding as manufactured by Buckaroo.

2.05 PRE-INSULATED HANGER SADDLES

A. Manufacturers:
   1. AeroFlix
   2. Klo Shure
   3. Buckaroo,Inc.
   4. Tru-Balance

B. Description: Completely assembled pre-insulated saddle assembly consisting of rigid PCF polyisocyanurate lock-joint insulation, vapor retardant facing flared edge bottom, center ribbed

saddle as manufactured by Tru-Balance 3300E series or equal.

2.06 JACKETS

A. PVC Plastic.
   1. Manufacturers:
      a. Proto Corporation Model LoSmoke.
      b. Johns Manville Model Zeston.
      c. Speedline Corp Model Smoke Safe.
      d. PROTO Corporation.
      e. Substitutions: See Section 01 6000 - Product Requirements.
   2. Field apply Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: 0 degrees F.
      b. Maximum Service Temperature: 150 degrees F.
      c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
      d. Thickness: 10 mil.
      e. Connections: Brush on welding adhesive.
      f. PVC 25/50 indoor / outdoor, UV-resistant fittings, jacketing and accessories, white or colored. complying with ASTM D 1784. Fitting cover system consists of pre-molded, high-inpact PVC materials with glass mineral wool inserts. Glass mineral wool inserts shall have a thermal conductivity (k value) of 0.26 at 75 degree F. mean temperature. Closures: stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations
   3. Factory Applied Jackets:
      a. Manufacturers:
         1) Knauf Model ASJ+ and Redi-Klad.
         2) Manville Model ASJ.
         3) Owens Corning Model ASJ.
      b. ASTM C 1136.
   4. Covering Adhesive Mastic: Compatible with insulation.

B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
   1. Thickness: 0.016 inch sheet.
   2. Finish: smooth or embossed.
   3. Joining: Longitudinal slip joints and 2 inch laps.
   4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
   6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

C. Stainless Steel Jacket: ASTM A666, Type 304 stainless steel.
   1. Thickness: 0.010 inch.
   2. Finish: Smooth.
   3. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 PREPARATION

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

B. Verify that surfaces are clean and dry, with foreign material removed.

3.03 APPLICATION

A. Glass Mineral wool insulation shall be used on piping systems.
   1. Exceptions:
      a. Cellular Elastomeric Insulation may be used on domestic water piping concealed in CMU wall.
      b. Cellular Elastomeric Insulation may be used on trap primer piping systems.

3.04 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install a complete insulation system, using all components, accessories, sealing devices, etc. as recommended by the pipe insulation manufacturer.

C. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.

D. Exposed Piping: Locate insulation and cover seams in least visible locations.

E. Keep insulation materials dry during application and finishing.

F. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

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

H. Cellular Elastomeric Insulation:
   1. Piping up to 4 inch inside diameter is to be insulated using preform pipe insulation. Piping over 4 inch inside diameter may be insulated with preform pipe insulation or sheet insulation, applied according to manufacturer's installation instructions and practices described in the National Commercial and Industrial Insulation Standards Manual.
   2. Insulated pipe saddles are to be installed at all pipe hanger and clamp locations. Saddles are to be installed at the time that piping is being installed, so that insulation system can be installed in a continuous manner through the pipe support system.

I. Glass Mineral Wool insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive, PVC or metal fitting covers.

J. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

K. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

L. Glass Mineral Wool insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC and or metal fitting covers.

M. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.

2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert Location: Between support shield and piping and under the finish jacket.
4. Insert configuration: Conforming to manufacturer's recommendations regarding length and spacing. Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Protection Shields: Of length recommended in writing by manufacturer to prevent crushing insulation.
6. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
7. Insulated Piping: Comply with the following:
    a. Shield Dimensions for Pipe: Not less than the following:
        1) NPS 1/4 to NPS 3: 12 inches long and 0.048-inch thick.
        2) NPS 4: 12 inches long and 0.06-inch thick.
        3) NPS 5 and NPS 6: 18 inches long and 0.06-inch thick.
        4) NPS 8 to NPS 14: 24 inches long and 0.075-inch thick.
    b. Pipes NPS 8 and Larger: Include wood inserts.
    c. Insert Material: Length at least as long as protective shield.
    d. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
8. Pre-insulated Hanger Spans: Thickness shall match the insulated thickness specified for piping
9. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
10. Use insulation saddles where insulation passes through a hanger location.
    a. Saddles shall be pre-insulated type with center partial rib on the bottom of the saddle.
    b. Saddles shall be non-insulated type with center partial rib on the bottom of the saddle.

N. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.

O. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Division 7 - Penetration Firestopping.
    1. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

P. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers; or install Knauf Earthwool Redi-Klad 1000° Pipe Insulation.
    1. Install in other areas as indicated on the drawings.

Q. Exterior Applications: Provide Knauf Earthwool Redi-Klad 1000° Pipe Insulation; or Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with stainless steel jacket with seams located on bottom side of horizontal piping.

R. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

S. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

T. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

U. 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.

3.05 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Inspect field-insulated equipment, randomly selected by Engineer or 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(s) for each type of insulation.
   2. Inspect pipe, fittings, strainers, and valves, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to five locations of straight pipe, three locations of threaded fittings, three locations of threaded valves, and three locations of flanged valves for each pipe service.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Remove and replace all insulation systems if any systems found defective.

3.06 SCHEDULES

A. Minimum thickness shall be in accordance with ASHRAE 90.1 - 2013 / IECC 2015

B. Plumbing Systems:
   1. Domestic Hot Water Supply:
      a. Glass Mineral Wool Insulation:
         1) Pipe Size Range: Less than 1 inch.
            (a) Thickness: 1 inch.
         2) Pipe Size Range: 1 inch to less than 1-1/2 inch.
            (a) Thickness: 1 inch.
         3) Pipe Size Range: 1-1/2 inch to less than 4 inch.
            (a) Thickness: 1-1/2 inch.
         4) Pipe Size range: 4 inch and larger.
            (a) Thickness: 2 inch.
      b. Cellular Foam Insulation:
         1) Pipe Size Range: Less than 1 inch.
            (a) Thickness: 1-1/2 inch.
         2) Pipe Size Range: 1 inch to less than 1-1/2 inch.
            (a) Thickness: 2 inch.
         3) Pipe Size Range: 1-1/2 inch and larger.
            (a) Thickness: 2 inch.
   2. Domestic Hot Water Recirculation:
      a. Glass Mineral Wool Insulation:
         1) Pipe Size Range: All sizes.
         2) Thickness: 1 inch.
      b. Cellular Foam Insulation:
         1) Pipe Size Range: All sizes.
         2) Thickness: 1 inch.
   3. Tempered Domestic Water Supply:
      a. Same as listed for domestic hot water supply.
   4. Domestic Cold Water:
      a. Glass Mineral Wool Insulation:
         1) Pipe Size Range: All Sizes.
         2) Thickness: 1 inch

b. Cellular Foam Insulation:
    1) Pipe Size Range: All Sizes.
    2) Thickness: 1 inch
5. Trap Primer supply Water:
    a. Glass Mineral Wool Insulation:
        1) Pipe Size Range: All Sizes.
        2) Thickness: 1 inch
    b. Cellular Foam Insulation:
        1) Pipe Size Range: All Sizes.
        2) Thickness: 1 inch
6. Roof Drain Bodies:
    a. Suitable insulate roof drain bottoms with blanket glass mineral wool or cellular elastomeric with factory applied insert and vapor barrier.
7. Roof Drainage Above Grade: horizontal and vertical
    a. Glass Mineral Wool Insulation:
        1) Pipe Size Range: All Sizes.
        2) Thickness: 1 inch
    b. Cellular Foam Insulation:
        1) Pipe Size Range: All Sizes.
        2) Thickness: 1 inch
8. Plumbing Vents Within 10 Feet of the Exterior:
    a. Glass Mineral Wool Insulation:
        1) Pipe Size Range: All Sizes.
        2) Thickness: 1 inch
    b. Cellular Foam Insulation:
        1) Pipe Size Range: All Sizes.
        2) Thickness: 1 inch

C. Other Systems:
1. Condensate and Equipment Drain Water below 60 degrees F
    a. Glass Mineral Wool Insulation:
        1) Pipe Size Range: All Sizes.
        2) Thickness: 1 inch
    b. Cellular Foam Insulation:
        1) Pipe Size Range: All Sizes.
        2) Thickness: 1 inch
2. Floor drains, traps, and sanitary drain piping within 20 feet of drains receiving condensate from Ice Machines.
    a. Glass Mineral Wool Insulation:
        1) Pipe Size Range: All Sizes.
        2) Thickness: 1 inch
    b. Cellular Foam Insulation:
        1) Pipe Size Range: All Sizes.
        2) Thickness: 1 inch
3. Domestic Water Heaters:
    a. Provided with factory insulation, meeting ASHRAE 90.1 requirements and as specified in Section 22 3000 Plumbing Equipment.
4. Piping Exposed to Freezing with Heat Tracing:
    a. Insulation one pipe size larger than scheduled.

END OF SECTION

SECTION 22 1005
PLUMBING PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Pipe, pipe fittings, specialties and connections for piping systems.
   1. Sanitary sewer
   2. Domestic water
   3. Storm water
   4. Radon exhaust piping
   5. Flanges, unions, and couplings.
   6. Pipe hangers and supports.
   7. Manufactured sleeve-seal systems.
   8. Water pressure reducing valves.
   9. Strainers.

1.03 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 07 8413 - Penetration Firestopping.

C. Section 08 3100 - Access Doors and Panels.

D. Section 09 9113 - Exterior Painting.

E. Section 09 9123 - Interior Painting.

F. Section 22 0516 - Expansion Fittings and Loops for Plumbing Piping.

G. Section 22 0523 - General Duty Valves for Plumbing Piping.

H. Section 22 0553 - Identification for Plumbing Piping and Equipment.

I. Section 22 0719 - Plumbing Piping Insulation.

J. Section 22 1123 - Facility Natural Gas Piping

K. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.04 REFERENCE STANDARDS

A. ANSI Z21.22 - American National Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems.

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.

D. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250.

E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

F. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

G. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.

H. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.

I. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.

J. ASME B31.1 - Power Piping.

K. ASME B31.9 - Building Services Piping.

L. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers.

M. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fuzing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications.

N. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

O. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

P. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

Q. ASTM B32 - Standard Specification for Solder Metal.

R. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.

S. ASTM B68/B68M - Standard Specification for Seamless Copper Tube, Bright Annealed.

T. ASTM B75/B75M - Standard Specification for Seamless Copper Tube.

U. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

V. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).

W. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.

X. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

Y. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

Z. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

AA. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

BB. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

CC. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

DD. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.

EE. ASTM D2855 - Standard Practice for the Two-Step (Primer & Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.

FF. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

GG. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

HH. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.

II. ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems.

JJ. ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-

RT) Tubing.

KK. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

LL. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.

MM. AWWA C606 - Grooved and Shouldered Joints.

NN. AWWA C651 - Disinfecting Water Mains.

OO. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.

PP. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

QQ. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements.

RR. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.

SS. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

TT. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

UU. NSF 61 - Drinking Water System Components - Health Effects.

VV. NSF 372 - Drinking Water System Components - Lead Content.

1.05 SUBMITTALS

A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

B. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

C. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

D. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

E. All cast iron pipe and fittings shall be marked with the Collective Trademark of the Cast Iron Soil Pipe Institute and listed by NSF International.

F. All components used in the domestic water system shall conform to the Safe Drinking Water Act, as amended on 01-04-2011 section 1417.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

C. Protect stored PE , PVC pipes and valves from direct sunlight.

1.08 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 CAST-IRON PIPE AND FITTINGS

A. Manufacturers:
   1. AB & I Foundry, City of Industry, CA
   2. Charlotte Pipe and Foundry, Charlotte, NC
   3. Tyler Corporation, Soil Pipe Division, Tyler, TX

2.03 PVC PIPE AND FITTINGS

A. Manufacturers:
   1. Charlotte Pipe and Foundry, Charlotte, NC
   2. Spears Manufacturing Co.

2.04 COPPER TUBE PIPE AND FITTINGS

A. Manufacturers:
   1. Muller Industries
   2. Cerroflow
   3. Streamline

2.05 STEEL PIPE AND FITTINGS

A. Manufacturers:
   1. Welbend
   2. Wheatland Tube Co.
   3. Ward Manufacturing

2.06 HUBLESS CAST IRON PIPE COUPLINGS

A. Standard Wide Body, Shielded, Stainless-Steel Couplings: With 304 stainless-steel shield; stainless-steel bands and tightening devices; ASTM C 564, rubber sleeve.
   1. Manufacturers:
      a. Husky SD 2000, White Shield Pipe Coupling, Corona, CA
      b. Clamp-All High Torq 80, Auburn Mills, MI
      c. Mission Heavy Weight (HW), Corona, CA

B. Heavy Duty, Shielded, Stainless-Steel Couplings: With 304 stainless-steel shield; stainless-steel bands and tightening devices; ASTM C 564, rubber sleeve.
   1. Manufacturers:
      a. Husky SD 4000, Orange Shield Pipe Coupling, Corona, CA
      b. Clamp-All High Torq 80, Auburn Mills, MI
      c. Mission Heavy Weight (SUMO), Corona, CA

2.07 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74 service weight.
   1. Fittings: Cast iron.
   2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets.

B. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.08 SANITARY SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
   2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies as specified herein.

B. Copper Tube: ASTM B306, DWV.
   1. Fittings: ASME B16.29, wrought copper, or ASME B16.23, sovent.
   2. Joints: ASTM B32, alloy Sn50 solder.
   3. Not for urinal waste.

2.09 SANITARY SEWER PIPING FOR BURIED KITCHEN WASTE

A. Cast Iron Pipe: ASTM A74, service weight.
   1. Fittings: Cast iron.
   2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.

2.10 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Copper Pipe: ASTM B42, hard drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.

B. Copper Pipe: ASTM B42, annealed.
   1. Fittings: ASME B16.26, cast bronze.
   2. Joints: Flared.

C. Ductile Iron Pipe: AWWA C151/A21.51.
   1. Fittings: Ductile or gray iron, standard thickness.
   2. Joints: AWWA C111/A21.11, styrene butadiene rubber (SBR) or vulcanized SBR gasket with 3/4 inch diameter rods.

2.11 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88, Type L
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: ASTM B32, alloy Sn95 solder.
   3. Joints: Grooved mechanical couplings.
      a. Manufacturers:
         1) Victaulic Company
         2) Anvil International
   4. Copper-Tube Extruded-Tee Connections: Tee formed in copper tube according to ASTM F2014
      a. Manufacturers:
         1) T-DRILL Industries
   5. Mechanical Press Sealed Fittings: Double pressed type, NSF 61 approved or certified, utilizing EPDM, non toxic synthetic rubber sealing elements. Copper press fittings shall conform to the material and sizing requirements of ASME B16.18.
      a. Manufacturers:
         1) Viega LLC:
         2) Nibco.
         3) Apollo XP

B. Cross-Linked Polyethylene (PEX) Pipe: ASTM F876 or ASTM F877.
   1. Manufacturers:
      a. Uponor, Inc: www.uponorengineering.com/#sle.
      b. Viega LLC: www.viega.us/#sle.
      c. Zurn Industries, LLC: www.zurn.com/#sle.

2. PPI TR-4 Pressure Design Basis:
   a. 160 psig at maximum 73 degrees F.
3. Fittings: Brass and engineered polymer (EP) ASTM F1960.
4. Joints: ASTM F1960 cold-expansion fittings.
5. Limitations: Use only on branch piping as indicated on the drawings and only in accessible locations.

2.12 STORM WATER PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. PVC Pipe: ASTM D3034 DR 35.
   1. Fittings: PVC.
   2. Joints: Push-on, using ASTM F477 elastomeric gaskets.

B. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.13 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.14 STORM WATER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
   2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies as specified herein.

2.15 RADON EXHUST PIPING

A. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

B. Above grade piping from slab to above roof is an alternate.

C. Radon piping installed in plenum rated areas shall be provided with UL rated and approved plenumWrap.

2.16 NATURAL GAS PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Polyethylene Pipe: ASTM D2513, SDR 11.
   1. Fittings: ASTM D2683 or ASTM D2513 socket type.
   2. Joints: Fusion welded.

B. Pipe material and pressure rating shall be approved by the Utility supplying the gas service.

2.17 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
   2. Joints: Threaded or welded to ASME B31.1.

2.18 DOUBLE CONTAINMENT PIPING

A. Description: Secondary containment piping system.

B. Material: Schedule 40 CPVC: Complete systems, including all necessary components for water tight secondary piping system.

C. Design: Design shall include a complete system, including carrier pipe, containment pipe, elbows, etc. The carrier pipe shall “float” within the containment piping system.

D. Primary piping shall be supported by centralizer brackets. Centralizers shall provide annular space suitable for drainage or installation of user-supplied leak detection cable.
   1. Available Manufacturers:
      a. Spears, Sylmar, CA.
      b. Substitutions: See Section 01 6000 - Product Requirements.
      c. Equal as approved by the Professional.

E. Locations:
   1. Install on all sanitary drainage systems located above main food service room and main laundry room ceilings.

2.19 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under:
   1. Ferrous pipe: Class 150 malleable iron threaded unions.
   2. Copper tube and pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Size Over 1 Inch:
   1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
   2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Mechanical Couplings for Grooved Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
   1. Dimensions and Testing: In accordance with AWWA C606.
   2. Housing Material: Provide ductile iron or galvanized.
   3. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
   4. Gasket Material: Nitrile rubber suitable for operating temperature range from minus 20 degrees F to 180 degrees F.
   5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
   6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
   7. Manufacturers:
      a. Grinnell Mechanical Products, a Tyco International Company:
      b. Anvil International.
      c. Substitutions: See Section 01 6000 - Product Requirements.

D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.20 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. B-Line Systems
   2. ERICO / Michigan Hanger Co.
   3. PHD Manufacturing
   4. Tolco Inc.
   5. Holdright

B. All pipe hangers and supports shall be electro galvanized or hot dipped galvanized.
   1. Exception: All supports directly in contact with copper lines shall be all copper or copper plated.

C. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
3. Trapeze Hangers: Welded steel channel frames attached to structure.
4. Vertical Pipe Support: Steel riser clamp.
5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.
6. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
    a. Bases: High density polypropylene.
    b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
    c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
    d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
    e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
    f. Manufacturers:
        1) PHP Systems/Design; PHP Pipe Supports
        2) maPa Products: Rooftop Piping Supports
        3) C-Port Roof Top Support Solutions

D. Plumbing Piping - Drain, Waste, Vent:
1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
3. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
4. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

E. Plumbing Piping - Storm:
1. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
2. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
3. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
4. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

F. Plumbing Piping - Water:
1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
2. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 2 Inches to 4 Inches: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
7. Wall Support for Hot Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.

8. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
10. All supports directly in contact with copper lines shall be all copper or copper-plated.

G. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
5. Other Types: As required.
6. Manufacturers:
a. Powers Fasteners, Inc:
b. Substitutions: See Section 01 6000 - Product Requirements.

H. Thermal-Hanger Shield Inserts:
1. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
2. Manufacturers:
a. ERICO/Michigan Hanger Co.
b. PHS Industries, Inc.
c. Pipe Shields, Inc.
d. Rilco Manufacturing Company, Inc.
3. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.
4. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate
5. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
6. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
7. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

I. Pipe Positioning Systems:
1. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
2. Manufacturers:
a. C & S Mfg. Corp.
b. HOLDRITE Corp.; Hubbard Enterprises.
c. Samco Stamping, Inc.

2.21 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Manufacturers:
1. The Metraflex Company
2. Link Seal.

B. Modular/Mechanical Seal:
1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
2. Provide watertight seal between pipe and wall/casing opening.
3. Elastomer element size and material in accordance with manufacturer's recommendations.
4. Glass reinforced plastic pressure end plates.

2.22 RELIEF VALVES

A. Pressure:
   1. Manufacturers:
      a. Cla-Val Co: www.cla-val.com.
      b. Henry Technologies: www.henrytech.com.
      c. Watts Regulator Company
      d. Substitutions: See Section 01 6000 - Product Requirements.
   2. ANSI Z21.22, AGA certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

B. Temperature and Pressure:
   1. Manufacturers:
      a. Cla-Val Co
      b. Henry Technologies
      c. Watts Regulator Company
      d. Substitutions: See Section 01 6000 - Product Requirements.
   2. ANSI Z21.22, AGA certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME BPVC-IV certified and labeled.

2.23 WATER PRESSURE REDUCING VALVES:

A. Water Regulators :
   1. Available Manufacturers:
      a. Cash Acme
      b. Conbraco Industries, Inc Apollo
      c. Cal-Val
      d. Watts Industries, Inc.; Water Products Div.
      e. Zurn Plumbing Products Group; Wilkins Div.
   2. NPS 2 and Smaller: Bronze body with threaded ends.
      a. Conbraco (Series 36H - 21X-01)
      b. Watts LF223
      c. Watts LF25AUB-Z3
   3. NPS 2-1/2 to 3: Bronze or iron body with threaded or flanged ends, direct acting, with built-in by-pass and strainer.
      a. Watts LF223
      b. Wilkins
      c. Apollo 36HLF,Series PRH-LF

B. Strainer: Provide strainer with each pressure reducing valve. Type as provided by PRV manufacturer.

2.24 STRAINERS

A. Y-Pattern Strainers:
   1. Available Manufacturers:
      a. Watts Industries, Inc.; Water Products Div.
      b. Zurn Plumbing Products Group; Wilkins Div.
      c. Apollo
   2. Pressure Rating: 125 psig minimum, unless otherwise indicated.
   3. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
   4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
   5. Screen: Stainless steel with round perforations, unless otherwise indicated.

6. Perforation Size:
    a. Strainers NPS 2 and Smaller: 0.033 inch
    b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch
7. Drain: Pipe plug for NPS 1-1/2-inch and smaller; Factory-installed, hose-end drain valve for NPS 2-inch and larger.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 GENERAL PIPING SYSTEMS INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 0516.

G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

H. Provide access where valves, trap and fittings are not exposed. Coordinate size and location of access doors with Division 08 - Access Doors and Panels.

I. Establish elevations of buried piping outside the building to ensure not less than 4 ft of cover.
    1. Exception: Unless noted otherwise on the drawings.

J. Install vent piping penetrating roofed areas to maintain integrity of roof assembly; refer to Division 7.

K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

L. Provide support for utility meters in accordance with requirements of utility companies.

M. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
    1. Painting of interior plumbing systems and components is specified in Section 09 9123.
        a. All exposed uninsulated water piping in Kitchen, Food Service Areas, Laundry shall be painted chrome color.
        b. All exposed drainage piping, P-traps, tail-piece, etc in Kitchen, Food Service Areas, Laundry, shall be painted chrome color.
    2. Painting of exterior plumbing systems and components is specified in Section 09 9113.

N. Excavate in accordance with Division 31, Earthwork.

O. Backfill in accordance with Division 31, Earthwork.

P. Install bell and spigot pipe with bell end upstream.

Q. Install valves with stems upright or horizontal, not inverted. Refer to Section 22 0523.

R. Install water piping to ASME B31.9.

S. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

T. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

U. Sleeve pipes passing through partitions, walls and floors.
   1. Refer to Section 22 0500 - Common Work Results For Plumbing.

V. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

W. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as indicated.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   8. Provide copper plated hangers and supports for copper piping.
      a. All supports directly in contact with copper lines shall be all copper or copper-plated.
   9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
   10. Support cast iron drainage piping at every joint.
   11. Hangers for cast iron pipe of all sizes shall be spaced so that each length of pipe shall have at least two hangers and each fitting one hanger, and not over 5 foot on centers. Hangers shall be entirely separate from hangers for all other pipe and shall be so located that there will be no strain on any joint. Hangers shall be provided at each horizontal branch connection, on each water closet bend or elbow and each trap.
   12. 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."
      a. Sanitary and storm piping over NPS 4 shall be suitably braced to prevent horizontal movement. This shall be done at every branch opening or change of direction by the use of braces, or other suitable methods, in accordance with CISPI's Cast Iron Handbook, to prevent movement.
   13. Install lateral bracing with pipe hangers and supports to prevent swaying. install on all pipe systems when individual hanger rods exceed four feet in length from support structure.
   14. All piping supports shall be hung from the building structural supports.
      a. Piping supported with beam clamps shall be attached to the top cord of structural joists.

b. Do not install hanger clamps at the joist ceiling leg extension of structural joists.

15. Lines 2 inches and smaller, supported on steel joists, shall be hung from one joist with beam clamps.
16. Lines 2 1/2-inches to 6 inches shall be suspended from a 1-1/4-inch by 1-1/4-inch by 1/4-inch steel angle, laid-in and hook-bolted to the web members of two joists
17. Closet bends, traps, trap-arms, and similar branches must be secured against movement in any direction. Closet bends installed above ground shall be stabilized by firmly strapping and blocking. Where vertical closet stubs are used they must be stabilized against horizontal or vertical movements. Floor drain traps, installed above first floor shall have trap supported.
18. The Contractor shall furnish all miscellaneous hardware items designed to be utilized with various support components such as bolts, nuts, washers, turnbuckles, etc. All thread must use lock nut or vibration resistant nuts where potential vibration may cause failure.

X. Manufactured Sleeve-Seal Systems:
   1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
   2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
   3. Locate piping in center of sleeve or penetration.
   4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
   5. Tighten bolting for a water-tight seal.
   6. Install in accordance with manufacturer's recommendations.

Y. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

Z. Piping Identification:
   1. Identify all piping systems; refer to Section 22055 - Identification for Plumbing Piping and Equipment.

AA. Place plugs in ends of uncompleted piping systems at end of each day and when work stops.

BB. Install cleanouts at grade and extend to where building sanitary and storm drains connect to building sewers.

CC. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

DD. 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.

3.04 SANITARY PIPING SYSTEMS INSTALLATION

A. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. 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 increaser and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

B. 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.

C. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Building Sanitary Drain: 1/4-inch per foot downward in direction of flow for piping NPS 3 and smaller; 1/8-inch per foot downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Drainage Piping: 1/4-inch per foot downward in direction of flow.
   3. Vent Piping: 1/8-inch per foot down toward vertical fixture vent or toward vent stack.
   4. Kitchen / Concession Waste Piping: 1/4-inch per foot downward in direction of flow.

D. Install engineered soil and waste drainage and vent piping systems as follows:
   1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

E. Install underground PVC soil and waste drainage piping according to ASTM D 2321. Minimum trench with shall be 16 inches. All PVC pipe shall have a minimum of 24 inches cover or backfill.

F. Sleeves are required for cast-iron soil piping passing through concrete slabs-on-grade.

G. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

H. Construct a complete sanitary sewer system, generally as indicated on the Drawings. Approximate invert elevations and grades of major lines are indicated on the Drawings. Contractor shall field check all such information before proceeding with his work to insure gravity drainage, before starting piping installation. Inform the Engineer if conditions do not permit gravity drainage or if conflict occurs between other systems.

I. The Plumbing Contractor shall terminate the interior sanitary system 5 feet from the exterior of the building wall or as indicated on the Drawings. Continuation of sanitary sewer piping shall be by the General Contractor. The Plumbing Contractor shall coordinate with the General Contractor in determining the exact location and inverts of the sanitary piping. Final connection shall be by the Plumbing Contractor.

J. Terminate vent piping 2 feet above the roof, unless vent location is within 10 feet horizontally of any air intake; in which case, extend vent a minimum of 2 feet above such device. Coordinate location of vents with Mechanical Contractor to avoid being within 10 feet of any air intake device.

K. After all fixtures are set and before the building is occupied by the Owner, rod entire existing (if applicable) and new sanitary and DWV systems by using all cleanouts, to insure no foreign material is present in the drain lines.
   1. Rodding of all systems shall be conducted in the presence of the Owner's Representative.

L. All underground sanitary drainage systems shall be flushed clean using the "Jet Spray" method (after rodding has been completed). Provide Engineer and Owner's Representative with certified report that all underground sanitary piping has been cleaned.

M. Sewer Service Connection:
   1. The Contractor shall contact the local Sewer Authority and coordinate all work related to the new sewer service.
   2. Provide new sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts, and ensure that these can be properly connected with slope for gravity drainage and cover to avoid freezing.
   3. The Contractor shall obtain all required certificates before start of any work and pay all fees and other charges required by local authorities.

N. Provide house trap and fresh air inlet, only if required by local sewer or code authorities where sewer line leaves the building perimeter.

O. 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 systems, 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.

3.05 STORM PIPING SYSTEMS INSTALLATION

A. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increaser and reducers if pipes of different sizes are connected. Reducing size of storm drainage piping in direction of flow is prohibited.

B. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
   1. Building Storm Drain: All Sizes: Minimum 1/8-inch per foot downward in direction of flow for piping unless indicated otherwise on drawings
   2. Horizontal Storm-Drainage Piping: Minimum 1/8-inch per foot downward in direction of flow unless indicated otherwise on drawings.

D. Sleeves are required for cast-iron soil piping passing through concrete slabs-on-grade.

E. Install underground PVC storm drainage piping according to ASTM D 2321. Minimum trench with shall be 16 inches. All PVC pipe shall have a minimum of 24 inches cover or backfill

F. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

G. Construct a complete storm sewer system, generally as indicated on the Drawings. Approximate invert elevations and grades of major lines are indicated on the Drawings. Contractor shall field check all such information before proceeding with his work to insure gravity drainage, before starting piping installation. Inform the Engineer if conditions do not permit gravity drainage or if conflict occurs between other systems.

H. The Plumbing Contractor shall terminate the interior storm drainage system 5 feet from the exterior of the building wall or as indicated on the Drawings. Continuation of storm sewer piping shall be by the General Contractor. The Plumbing Contractor shall coordinate with the General Contractor in determining the exact location and inverts of the storm piping. Final connection

shall be by the Plumbing Contractor.

I. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   5. Prepare reports for tests and required corrective action.

J. Insulate interior storm drainage systems, refer to Section 22 0719 - Plumbing Piping Insulation.

3.06 RADON PIPING SYSTEMS INSTALLATION

A. Make changes in direction for radon exhaust piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees.

B. Install radon piping at the following minimum slopes, unless otherwise indicated:
   1. Minimum 1/8-inch per foot upward in direction of flow for piping unless indicated otherwise on drawings
   2. Route piping as vertical as possible. Terminate with turn-down elbow 24" above roof level and not within 10 horizontal feet of any air intake devices. Provide offsets as required.

C. Provide UL Plenum wrap on all radon piping systems installed in plenum rated spaces.

D. Coordinate location of system exhaust fan with Mechanical and Electrical Contractosr. Exhaust fan provided by Mechanical Contractor.

3.07 DOMESTIC WATER PIPING SYSTEMS INSTALLATION

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

B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.

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

D. Install piping concealed from view and protected from physical contact by building occupants 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, and coordinate with other services occupying that space.

G. Install piping adjacent to equipment to allow service and maintenance.

H. Install piping to permit valve servicing.

I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating.

J. Install piping free of sags and bends.

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

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

M. The Plumbing Contractor shall terminate the interior water piping system 5 feet from the exterior building wall or as indicated on the Drawings. Continuation of water piping shall be by the General Contractor. The Plumbing Contractor shall coordinate with the General Contractor in determining the exact location and invert elevation of the water piping. Final connection shall be by the Plumbing Contractor.

N. Inspection and Testing:
   1. Piping Inspections:
   2. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   3. 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:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   4. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   5. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
   6. 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, but no less than 150 psig, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
      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.
      g. Domestic water piping will be considered defective if it does not pass tests and inspections.
      h. Prepare test and inspection reports.
   7. Insulate all domestic water systems, refer to Section 220719 - Plumbing Piping Insulation.

3.08 GENERAL PIPE SYSTEMS APPLICATIONS

A. Use grooved mechanical couplings and fasteners only in accessible locations.

B. Install unions downstream of valves and at equipment or apparatus connections.

C. Install gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

3.09 CAST-IRON PIPE COUPLINGS APPLICATIONS

A. Aboveground, soil and waste piping NPS 4 and smaller shall be:
   1. Hubless cast-iron soil pipe and fittings; standard wide body shielded, stainless-steel couplings; and hubless-coupling joints.
   2. Dissimilar Pipe-Material Couplings: Flexible, shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

B. Aboveground, soil and waste piping NPS 5 and larger shall be:
   1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
   2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Aboveground, vent piping NPS 4 and smaller shall be:
   1. Hubless cast-iron soil pipe and fittings; standard wide body shielded couplings; and hubless-coupling joints.
   2. Dissimilar Pipe-Material Couplings: Flexible, Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

D. Aboveground, vent piping NPS 5 and larger shall be:
   1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
   2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

E. Aboveground, storm drainage piping shall be:
   1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
   2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

F. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
   1. All couplings shall be tightened to the manufacturer's required inch pound of torque using the coupling manufacturer’s pre-set torque wrenches and in the proper tightening sequence.

3.10 DOMESTIC WATER PIPING APPLICATIONS

A. Under-building-slab, domestic water, building service piping, NPS 3 and smaller.
   1. Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
   2. Pex tubing: NPS1 and smaller.
      a. For under slab trap primer supply piping enclosed in elastomeric pipe insulation.
      b. Other areas as specified herein.

B. Under-building-slab, domestic water, building-service piping, NPS 4 and larger, shall be one of the following:
   1. Same as specified for exterior water distribution piping.

C. Under-building slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:
   1. Same as specified for exterior combination water fire service.

D. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
   1. Hard copper tube, ASTM B 88, Type L; wrought- copper solder-joint fittings; and soldered joints.

2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 3, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; wrought- copper solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

F. Aboveground domestic water piping, NPS 4 and Larger, shall be the following:
1. Hard copper tube, ASTM B 88, Type L; wrought- copper solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; grooved-joint copper-tube appurtenances; and grooved joints.
3. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

G. Press Connections: Copper press fittings shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fittings and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

H. Mechanically form tee-branch outlets and brazed joints. For "tee connections" 4 inches by 4 inches by 2 inches and smaller.

I. Grooved Connections: Installed in accordance with manufacturers written instructions.

3.11 TOLERANCES

A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/8 inch per foot slope or as indicated on the drawings.

B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.12 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfect exterior water distribution system in accordance with Section 33 1300.

B. Disinfect interior water systems in accordance with local authorities requirements and the following requirements listed in the followig paragraphs.

C. Prior to starting work, verify system is complete, flushed and clean.

D. Use purging and disinfecting procedures prescribed by authorities having jurisdiction.

E. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using

F. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

G. Maintain disinfectant in system for 24 hours.

H. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

I. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

J. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

K. Prepare and submit reports of purging and disinfecting activities. Provide report to Engineer and Owner indicating water is safe for human consumption.

3.13 SERVICE CONNECTIONS

A. Provide new sanitary and storm sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves, pressure reducing valve if indicated.
   1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Calk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall or floor slab.
   2. Provide concrete thrust blocking and anchor water service to thrust blocking for water services over 2 inches.
   3. All materials and workmanship shall meet the Water Company requirements.
   4. The Contractor shall obtain all required certificates before start of any work, and pay all fees and other charges, required by local authorities.

3.14 SCHEDULES

A. Cast-iron piping spacing: Install hangers 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: 60 inches with 3/4-inch rod.
   5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
   6. Install supports for vertical cast-iron piping every 10 feet.

B. Steel piping spacing: Install hangers with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3: 12 feet with 1/2-inch rod.

C. PVC piping spacing: Install hangers with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
   2. NPS 3: 48 inches with 1/2-inch rod.
   3. NPS 4 and 5: 48 inches with 5/8-inch rod.
   4. NPS 6: 48 inches with 3/4-inch rod.
   5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.
   6. Install supports for vertical PVC piping every 48 inches.

D. Copper tubing spacing: Install hangers with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   4. NPS 2-1/2: 108 inches with 1/2-inch rod.
   5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   6. NPS 6: 10 feet with 5/8-inch rod.
   7. Install supports for vertical copper tubing every 10 feet.

E. PEX tubing: Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.
   2. NPS 1-1/4 and larger: Install in accordance with pipe manufacturers written instructions.
   3. Install hangers for vertical PEX piping every 48 inches.

F. Support piping and tubing not listed in this article according to MSS-SP-69 and manufacturer's written instructions.

END OF SECTION

SECTION 22 1006
PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Drains.
B. Roof and floor drains
C. Prefabricated Trench Drain Systems
D. Floor Sinks
E. Cleanouts
F. Hose Bibb
G. Hydrants
H. Washing machine boxes and valves.
I. Reduced Pressure Zone Backflow preventers
J. Double check valve assemblies.
K. Vacuum Breakers
L. Water hammer arrestor
M. Exterior Underground Grease Interceptor.
N. Mixing valves
O. Trap seal primer valves and systems
P. Miscellaneous sanitary drainage piping specialties.

1.03 RELATED REQUIREMENTS

A. Section 22 1005 - Plumbing Piping.
B. Section 22 4000 - Plumbing Fixtures.

1.04 REFERENCE STANDARDS

A. ASME A112.6.3 - Floor and Trench Drains.
B. ASME A112.6.4 - Roof, Deck, and Balcony Drains.
C. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
D. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent.
E. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers.
F. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance.
G. NSF 61 - Drinking Water System Components - Health Effects.
H. NSF 372 - Drinking Water System Components - Lead Content.
I. PDI-WH 201 - Water Hammer Arresters.

1.05 SUBMITTALS

A. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Loose Keys for Outside Hose Bibb: One.
   3. Extra Hose End Vacuum Breakers for Hose Bibb: One.
   4. Service Kits for Wall Hydrants: Minimum one for every four wall hydrants.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.07 COORDINATION

A. Coordinate the installation of roof drains with the roofing manufacturer and Roofing Contractor.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

B. Floor drains and cleanouts located above finished slab on grade shall be provided with flashing collar or flange to prevent leakage between drain body and floor below.

2.02 DRAINS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company:
   2. Josam Company:
   3. Sioux Chief - Finish Line-Adjustable Drainage System
   4. Zurn Industries, Inc:

B. Roof Drains: (RD-1)
   1. Assembly: ASME A112.6.4.
   2. Body: Lacquered cast iron with sump.
   3. Strainer: Removable polyethylene dome with vandal proof screws.
   4. Accessories: Coordinate with roofing type, refer to Section 07 5300:
      a. Membrane flange and membrane clamp with integral gravel stop.
      b. Adjustable under deck clamp.
      c. Roof sump receiver.
      d. Waterproofing flange.
      e. Adjustable extension sleeve for roof insulation.
   5. Model Zurn ZA 100 CER-VP or approved equal.
      a. Note: Top Set equivalent drains (ZA 100-DP-E-VP would be consider an equal.)
   6. Roof drains with adjacent Emergency Overflow Drains (if required) (ORD-1) Zurn 15" diameter roof drain. Same as specified for RD-1, with 2-inch internal water dam, or as indicated on the drawings.
      a. Note: Combination main roof drain with double top set will be acceptable where conditions permit. Zurn model Z-163-15" ZA-DR-EA-VP with 2-inch dam height or dam height as indicated on the drawings.

C. Roof Drains: RD-2
   1. Same as specified for RD-1, except with 90 degree side outlet.

D. Floor Drain (FD-1)
   1. ASME A112.6.3; lacquered cast iron body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable 6" stainless steel, heel-proof, medium-duty strainer assembly. Under deck clamp for all floor drains above slab on grade. Vandal proof screws
      a. Zurn Model ZS-415BS-VP or approved equal.
      b. Anchor Flange with Clamp Collar: Provide with all floor drains located above grade with 36-inch by 36-inch neoprene flashing or approved waterproof material.

E. Floor Drain (FD-1/FNL)
   1. Same as FD-1, except provided with funnel converting assembly.
      a. Zurn Model ZS-329 or approved equal.

F. Floor Drain (FD-1/TP)
   1. Same as FD-1, except provided with trap primer connection.
      a. Zurn Model ZS-415-VP-TP or approved equal.

G. Floor Drain (FD-2)
   1. ASME A112.6.3; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, sediment bucket and round 9-inch Ductile Iron extra heavy duty grate. Provide funnel assembly where indicated.
      a. Zurn Model Z550-9-DG-SS-Y with ZN-329-9" funnel assembly.

H. Floor Drain (FD-3)
   1. ASME A112.6.3 9-1/4" Diameter top drain, lacquered coated galvanized cast iron body heavy duty drain with bottom outlet, seepage pan, membrane flashing clamp with seepage slots, and adjustable extension frame with heavy-duty duresist grate, stainless steel sediment bucket, vandal-proof secured top.
      a. Zurn Model Z520-DG-SS-VP-Y or approved equal.
      b. Anchor Flange with Clamp Collar: Provide with all floor drains located above grade with 36-inch by 36-inch neoprene flashing or approved waterproof material.

I. Floor Drain (FD-4)
   1. ASME A112.6.3; Black epoxy coated floor receptor. 12" x 6" 7-3/4" deep. Factory applied black epoxy coated-interior and top or all galvanized. Seepage holes with clamp collar. Anti-splash interior bottom dome strainer and aluminum bucket. 1/2 grate.
      a. Zurn Model Z1940-KC-23-33-2 with factory applied black epoxy coating.

J. Floor Drain (FD-5)
   1. Same as FD-1, except provided with raised lip strainer assembly
      a. Zurn Model ZS-415BS-I-VP

K. Prefabricated Trench Drain (TDS-1): Trench drain system with modular channel sections make of 0% water absorbent High Density Polyethylene (HDPE). Channels shall be 96 inches long, 12 inch wide reveal and have a 9-1/4" throat, positive mechanical connection between channel sections that will not separate during the installation and shall mechanically lock into the concrete surround every 12 inches. Grate lockdown bars are to be integral to the frame.
   1. Basis of Design: Zurn Industries, LLC. Model Series Z882.
   2. Grating Material and Style: Galvanized Heel Proof Ductile Iron Slotted Grate: 11-1/4 inches wide by 24 inches long, weighting 19.5 lbs per linear foot. 60.3 square inches of open area per linear foot. DIN Rating of E, ANSI Rating of Special-Duty, H-20 Load rated, FAA Rated. Galvanizing (hot dip) shall conform to ASTM specification A123.
      a. Zurn P12-HPDE-USA

3. Catch Basin: Catch basins material, grating, frame and load rating shall be of same as channel system. Minimum Depth 24". Actual depth as required to meet specific field conditions.
    a. Catch Basin (CB-1) 12" x 24"

L. Floor Sink (FS-1)
1. 16 gauge, all Type 304 (CF8) Stainless Steel Sani-Floor receptor with non-tilt, loose set extra heavy duty grate, secured with vandal-proof stainless steel screws, 1/2" square openings and anti-splash stainless steel interior dome strainer. Seepage pan and weep holes. Above slab drains shall be provided with anchor flange, seepage holes and clamp collar.-KC
2. Size: 12" x 12" x 6" deep.
    a. Zurn Model: Z1750-HD-K-VP

M. Floor Sink (FS-2)
1. Same as FS-1, except with 1/2 grate.

N. Floor Sink (FS-3)
1. Same as FS-1, except with 3/4 grate.

2.03 CLEANOUTS

A. Manufacturers:
1. Jay R. Smith Manufacturing Company
2. Josam Company
3. Sioux Chief-Finish Line - Adjustable Drainage System
4. Zurn Industries, Inc

B. Cleanouts at Exterior to Grade Areas
1. Heavy duty cleanout housing, lacquered coated cast iron body with integral flange, Round ductile iron gasketed cover, gasketed cover, vandal proof screws.
    a. Zurn Model ZN-1474-DC-N-SG-VP or approved equal.

C. Cleanouts at Interior Finished Floor Areas
1. Adjustable, Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.
2. Carpet Marker: Provide with all cleanouts in receiving carpets.
    a. Zurn Model Series ZN-1400 Series or approved equal.
3. Anchor Flange with Clamp Collar: Provide with all cleanouts above grade with 36-inch by 36-inch neoprene flashing

D. Cleanouts at Interior Finished Wall Areas
1. Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.
    a. Zurn Model ZS-1469 or approved equal.

E. Cleanouts at Interior Unfinished Accessible Areas: Calked or threaded type. Provide bolted stack cleanouts on vertical sanitary and rainwater leaders.

2.04 HOSE BIBB

A. Manufacturers:
1. Jay R. Smith Manufacturing Company
2. Watts Regulator Company
3. Zurn Industries, Inc:

B. Interior Hose Bibb: HB-1

1. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed with handwheel, integral vacuum breaker in compliance with ASSE 1011.

C. Interior Mixing Type Hose Bibb: HB-2
   1. Bronze or brass, wall mounted, double service faucet with hose thread spout, integral stops, chrome plated where exposed with handwheels, and vacuum breaker in conformance with ASSE 1011.
      a. Chicago Faucet Model 445-897SRCXKCP or approved equal.

D. Interior Hose Bibb: HB-1T
   1. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, stainless steel, hex key, flush mounted, integral vacuum breaker in conformance with ASSE 1011.
      a. Zurn Model Z1333 or approved equal.

2.05 HYDRANTS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company
   2. Josam
   3. Zurn Industries, Inc

B. Wall Hydrant: WH-1
   1. ASSE 1019; freeze resistant, self-draining type with stainless steel wall box and locking hinged cover, hose thread spout, operating key, and integral vacuum breaker.
      a. Zurn Model Z1320-CL-RK

C. Wall Hydrant WH-2
   1. ASSE 1019; Combination Hot and Cold freeze resistant, self-draining type with stainless steel wall box and locking hinged cover, hose thread spout, operating key, and integral vacuum breaker.
      a. Zurn Model Z1325-CL-RK or approved equal.

D. Roof Hydrant: RH-1
   1. Non Freeze roof hydrant, with roof mounting system to support hydrant to roof with under deck flange, shim, boot cover, drain port. ASSE 1052 listed dual check backflow preventer.
      a. Woodford Model RHY2-MS

2.06 WASHING MACHINE BOXES AND VALVES

A. Box Manufacturers
   1. Oatey
   2. Guy Grey

B. Valve Manufacturers:
   1. Zurn Industries, Inc:
   2. Watts
   3. Guy Grey

C. Description: Stainless steel preformed rough-in box with brass valves with single lever handle, socket for 2 inch waste, slip in finishing cover.

2.07 REDUCED PRESSURE ZONE BACKFLOW PREVENTERS

A. Manufacturers:
   1. Apollo Valve:
   2. Watts Regulator Company:
   3. Wilkins

4. Zurn Industries, Inc:

B. Reduced Pressure Backflow Preventers:
   1. ASSE 1013; bronze body with bronze internal parts or stainless steel and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two shutoff valves-ball type for 2" and smaller, OS&Y for 2-1/2" and larger, factory supplied strainer, and four test cocks. Lead Free.

C. Sizes 2 inch and smaller:
   1. Apollo RPLF4A
   2. Watts LF009QT
   3. Wilkins

D. Sizes 2-1/2 inch and larger
   1. Apollo RPLF4A
   2. Watts Stainless Steel-957NRS/OSY
   3. Wilkins

E. Accessories:
   1. Strainer: Type provided by backflow preventer. If indicated.
   2. Air-gap fitting: ASME A112.1.2 matching backflow preventer connection.

2.08 DOUBLE CHECK VALVE ASSEMBLIES

A. Manufacturers:
   1. Apollo:
   2. Watts Regulator Company:
   3. Wilkins
   4. Zurn Industries, Inc:

B. Double Check Valve Assemblies:
   1. ASSE 1012; Bronze body with corrosion resistant internal parts or stainless steel and stainless steel springs; two independently operating check valves with intermediate atmospheric vent, shutoff valves and factory supplied strainer. Lead Free.

C. Sizes 2 inch and smaller:
   1. Apollo DCLF4A
   2. Watts LF007QT
   3. Wilkins

D. Sizes 2-1/2 inch and larger
   1. Apollo DCLF4A
   2. Watts Stainless Steel 757 NRS/OSY
   3. Wilkins

2.09 VACUUM BREAKER

A. Manufacturers:
   1. Conbraco Industries:
   2. Watts Regulator Company:
   3. Woodford

B. Standard: ASSE 1011

C. Body: Bronze non-removable.

2.10 CARBONATED BEVERAGE-DISPENSING-EQUIPMENT BACKFLOW PRVENTERS

A. Manufacturers:

1. Conbraco Industries; Model Apollo CBBP Series:
2. Watts Regulator Company; Model SA2/SD3:
3. Woodford
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Standard: ASSE 1022

C. Size: 3/8 inch.

D. Body: Stainless steel.

E. Strainer.

2.11 HOSE END VACUUM BREAKER

A. Manufacturers:
1. Apollo Series HBV2
2. Watts Regulator Company:
3. Woodford

B. Standard: ASSE 1052

C. Operation: Up to 10-foot head of water back pressure.

D. Outlet Size: Garden-hose thread complying with ASME B1.20.7.

E. Capacity: Minimum 3 gpm.

2.12 WATER HAMMER ARRESTORS

A. Manufacturers:
1. Jay R. Smith Manufacturing Company:
2. Watts Regulator Company:
3. PPP
4. Sioux Chief

B. Water Hammer Arrestors:
1. Stainless steel construction, piston type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psi working pressure. Threaded connections.

2.13 EXTERIOR PASSIVE UNDERGROUND GREASE INTERCEPTORS

A. Manufacturers:
1. Highland Tank and Manufacturing Company
2. Roger Jones
3. Schire - Requires Local Jurisdiction approval.

B. Triple Basin Interceptor:
1. Single-Wall UL Type I 360, underground steel Triple basin Interceptor (SBI) tank, constructed in accordance with Underwriters Laboratories' Standard 58 and externally coated with the HighGuard corrosion protection system in conformance with Underwriters Laboratories' Standard 1746
2. The Interceptor shall be the standard product of a steel tank manufacturer regularly engaged in the production of such equipment. No subcontracting of tank fabrication shall be permitted. The Interceptor shall be fabricated, inspected and tested for leakage before shipment from the factory by the manufacturer as a complete assembled vessel ready for installation.
3. The interceptor shall be a cylindrical, horizontal, atmospheric-type steel vessel intended for the separation and storage of sand, grit, grease and free oil (hydrocarbons and other petroleum products). The separator shall have the structural strength to withstand normal burial static and dynamic hydraulic loading to 5 feet below grade while empty and during

operating conditions.

4. The exterior corrosion control system shall be in strict accordance with HighGuard specifications and shall have a limited 30-year warranty against failure due to exterior corrosion and internal corrosion when used with petroleum products or alcohols.
5. 36” inch diameter manholes (s) complete with extension shall be placed over each tank access to facilitate access into basin for inspection, pumping, cleaning, and access. Heavy-duty striker plates shall be placed under the manhole to protect the tank shell.
6. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step.
7. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
8. Manhole Frames and Covers: 30-inch- diameter cover.
    a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
    b. Include indented top design with lettering cast into cover, using wording equivalent to GREASE INTERCEPTOR
    c. Protective Coating: Foundry-applied, epoxy-polyamide paint; 15-mil minimum thickness applied to all ferrous surfaces.

C. Capacity and Equipment and additional Specifications:
    1. Refer to detail on drawings

2.14 MIXING VALVES

A. Thermostatic Mixing Valves:
    1. Manufacturers:
        a. Leonard Valve Company
        b. Lawyer
        c. Symmons
        d. Bradley
    2. Valve: Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment. Lead Free
    3. Capacity / Type: Refer to Thermostatic Temperature Control Valve Schedule on drawings.
    4. Accessories:
        a. Check valve on inlets.
        b. Volume control shut-off valve on outlet.
        c. Stem thermometer on outlet.
        d. Strainer stop checks on inlets.
    5. Cabinet: 16 gage, 0.0598 inch stainless steel, for surface mounting with keyed lock. Where indicated.

2.15 TRAP SEAL PRIMER VALVES

A. Manufacturers:
    1. PPP Inc
    2. Sioux Chief
    3. Watts

B. Standard: ASSE 1018

C. Pressure rating: 125 psi

D. Body: Bronze or stainless steel.

E. Inlet and outlet connections: NPS 1/2 threaded or solder.

F. Gravity drain outlet connections: NPS 1/2 threaded or solder.

G. Outlets: One to Four: as indicated on drawings.

2.16 TRAP SEAL PRIMER SYSTEMS

A. Manufacturers:
   1. PPP Inc
   2. Sioux Chief:
   3. Watts

B. Standard: ASSE 1044

C. Piping: NPS 3/4, ASTM B88, Type L;copper

D. Cabinet: Surface mounted steel box with stainless steel cover.

E. Electric Controls: 24 hour timer, solenoid valve, and manual override switch for 120 VAC.

F. Vacuum breaker: ASSE 1001.

G. Number of outlets: As indicated on drawings.

H. Model: PPP PTS-1320 or equal.

2.17 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains / Hub Drains:
   1. Oatey
   2. ProSet Systems
   3. Studor, Inc

B. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.

C. Size: Same as connected waste piping with increaser fitting of size indicated.

D. Deep-Seal Traps:
   1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
   2. Size: Same as connected waste piping.
      a. NPS 2: 4-inch- minimum water seal.
      b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

E. Floor-Drain, Trap-Seal Primer Fittings:
   1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
   2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

F. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
   2. Body: Bronze or cast iron.
   3. Inlet: Opening in top of body.
   4. Outlet: Larger than inlet.
   5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

G. Sleeve Flashing Device:
   1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
   2. Size: As required for close fit to riser or stack piping.

H. Stack Flashing Fittings:
   1. Description: Counter flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
   2. Size: Same as connected stack vent or vent stack.

I. Drain Gap Device:
   1. Description: Manufactured, plastic air gap device for providing code required air gap at floor sink, floor drains and hub drains.
   2. Manufacturer: Tru Gap, North St Paul, MN.

PART 3 EXECUTION

3.01 CERTIFICATION

A. Thermostatic Water Mixing Valves
   1. Manufacturers of various thermostatic water mixing valves recommend different ways of piping their individual valves. Contractor is required to pipe all piping, including hot water recirculation piping per manufacturer's printed instructions. Provide written verification to Owner and Engineer that all temperature control valves have been piped according to manufacturers recommendations.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Install cleanouts in sanitary and storm above ground 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 cleanout size is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at the base of every soil and storm water stack.

F. Install floor drains at low points of surfaces to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Set floor drains below elevation of surrounding finish 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" 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.
   2. Install floor drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membrane where penetrated.
   3. Install individual traps for floor drains connected to sanitary building drain.

G. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
   1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.

2. Position roof drains for easy access and maintenance.
3. Install expansion joints on vertical stacks, where offset from roof drain to horizontal pipe is less than 4 feet. Position expansion joints for easy access and maintenance.
4. Insulate bottom of all roof drain assemblies. Insulate both horizontal and vertical interior storm drain piping systems. Refer to Section 22 0719 Plumbing Piping Insulation.
5. Install emergency overflow nozzles / covers where indicated. Locations shown on the exterior face of the building are approximate and exact location shall be coordinated with the Architect and Construction Administrator at time of installation. Downspout nozzles / covers shall be installed at a uniform height around the building. Install the same diameter cover for all piping on same side of the building, based on the largest pipe size.

H. Install supply-type, trap seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent and connect to floor drain body trap or inlet fitting. Adjust valve for proper flow. Provide access panel to permit servicing and replacing trap primer valve.

I. Install deep-seal traps on all floor drains.

J. Install sleeve flashing device with each riser and stack passing through floors width waterproof membrane.

K. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons, if required to conceal protruding pipe fittings.

L. Install approved portable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms sinks, fire sprinkler systems, irrigation systems, flush valves, interior and exterior hose bibb.

M. Pipe relief from backflow preventer to nearest drain.

N. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to all quick closing valves. Install in other locations as indicated on drawings.
1. Provide and install access panels where arrestors are not accessible
2. Provide threaded type water hammer arrestors for easy removal.

END OF SECTION

SECTION 22 1123
FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Pipe, pipe fittings, valves, and connections for natural gas piping systems.

1.03 RELATED REQUIREMENTS

A. Section 08 3100 - Access Doors and Panels.

B. Section 09 9113 - Exterior Painting.

C. Section 09 9123 - Interior Painting.

1.04 REFERENCE STANDARDS

A. ANSI Z21.18/CSA 6.3 - Gas Appliance Pressure Regulators.

B. ANSI Z21.80/CSA 6.22 - Line Pressure Regulators.

C. ANSI Z223.1 - National Fuel Gas Code.

D. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fuzing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications.

E. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.

F. ASME B31.1 - Power Piping.

G. ASME B31.9 - Building Services Piping.

H. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

I. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

J. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

K. ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings.

L. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.

M. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

N. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

O. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.

P. MSS SP-85 - Cast Iron Globe & Angle Valves, Flanged and Threaded Ends.

Q. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends.

1.05 SUBMITTALS

A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

B. Welder Certificate: Include welders certification of compliance with ASME BPVC-IX.

C. Project Record Documents: Record actual locations of valves.

1.06 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

E. Identify pipe with marking including size, ASTM material classification, and ASTM specification.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.08 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 NATURAL GAS PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Polyethylene Pipe: ASTM D2513, SDR 11.
   1. Fittings: ASTM D2683 or ASTM D2513 socket type.
   2. Joints: Fusion welded.

B. Pipe material and pressure rating shall be approved by the Utility supplying the gas service.

2.02 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
   1. Fittings: ASTM A234/A234M, wrought steel welding type.
   2. Joints: ANSI Z223.1, welded.
   3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.03 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
   2. Joints: Threaded or welded to ASME B31.1.

2.04 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under:
   1. Ferrous pipe: Class 150 malleable iron threaded unions.

2.05 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
   3. Trapeze Hangers: Welded steel channel frames attached to structure.
   4. Vertical Pipe Support: Steel riser clamp.

5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.
6. Hangers for steel gas pipe shall be provided with PVC coated hanger assemblies.
7. Hangers for Pipe Sizes 1/2 inch to 1-1/2 inches: Carbon steel, adjustable swivel, split ring.
8. Hangers for Pipe Sizes 2 inches and over: Carbon steel, adjustable clevis.
9. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
    a. Bases: High density polypropylene.
    b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
    c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
    d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
    e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
    f. Manufacturers:
        1) PHP Systems/Design; PHP Pipe Supports: www.phpsd.com.
        2) C-Port Roof Top Support Solutions.
        3) Substitutions: See Section 01 6000 - Product Requirements.

B. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
    1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
    2. Concrete Screw Type Anchors: Complying with ICC-ES AC193.

2.06 MANUAL GAS SHUTOFF VALVES

A. General Requirements:
    1. All valves used in the gas piping system shall be certified and UL/AGA listed for required gas pressure.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33. UL/AGA
    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. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38. UL/AGA.
    1. CWP Rating: 125 psig.
    2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
    3. Tamperproof Feature: Locking feature for valves.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
    1. Body: Bronze, complying with ASTM B 584, UL / AGA stamped
    2. Ball: Chrome-plated bronze.
    3. Stem: Bronze; blowout proof.
    4. Seats: Reinforced TFE; blowout proof.
    5. Packing: Threaded-body packnut design with adjustable-stem packing.
    6. Ends: Threaded, flared, or socket.
    7. CWP Rating: 600 psig.
    8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
    9. Service: Suitable for natural-gas service.

10. Manufacturers:
    a. Nibco T-585-70-UL

E. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B 584.UL/AGA
2. Plug: Bronze.
3. Ends: Threaded, socket, or flanged.
4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125 psig.
6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service.

F. Cast-Iron, Lubricated Plug Valves: MSS SP-78.UL/AGA
1. Body: Cast iron, complying with ASTM A 126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural gas.
5. Ends: Threaded or flanged.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service.

G. Valve Boxes:
1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.

H. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve

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

10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
11. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.
1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Overpressure Protection Device: Factory mounted on pressure regulator.
10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.
1. Body and Diaphragm Case: Die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber.
5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.

E. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 GAS PIPING SYSTEMS INSTALLATION

A. General gas service installation:
1. The Contractor shall contact the supplying gas company to coordinate all work related to the new gas service.
a. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
2. Comply with NFPA 54, International Fuel Gas Code, and Gas Company's printed rules and installation for installation and purging of natural-gas piping.
3. All material and workmanship, both interior and exterior, shall meet the Gas Company's requirements.
4. All work downstream of the gas meter shall be provided by the Contractor under supervision of the Gas Company.

5. The Contractor shall obtain all approved certificates before start of any work; pay all required fees, and other charges required by the local authorities.
6. All gas regulators, except the main gas regulator at the Utilities gas meter set, shall be set by the contractor to provide required pressure.
7. The building's gas regulators pressure shall be calibrated when the building gas consumption is near full load.
8. When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting main buildings gas service regulator(s) to suit actual occupied conditions. Provide up to two visits for this purpose.
9. Identify all underground gas piping systems on "Record Drawings" by use of dimensions from fixed reference points.

B. Performance Requirements:
1. Minimum Operating-Pressure Ratings:
   a. Piping and Valves: 100 psig minimum unless otherwise indicated.
   b. Service Regulators: 100 psig minimum unless otherwise indicated.
2. Natural-Gas System Pressure within building: 0.5 psig or less.

C. Indoor piping installation:
1. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
2. 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.
3. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
4. 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.
   a. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
5. Extend individual relief vent connections for all interior service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap. Vent piping shall be copper and shall be at least two pipe sizes larger than connection to regulator with minimum diameter of 3/4".
6. Concealed Location Installations:
   a. Above Accessible Ceilings: Natural-gas piping and fittings may be installed in accessible spaces without containment conduit.
   b. Prohibited Locations:
      1) Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts or elevator shafts.
      2) Do not install natural-gas piping in solid walls or partitions.
7. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
8. Connect branch piping from top or side of horizontal piping.
9. Do not use natural-gas piping as grounding electrode.
10. Gas Pressure Regulator:
    a. Verify all gas pressure is the correct pressure for the installation. Provide sensing line as required to control outlet pressure under all flow conditions. Adjustment of gas pressure regulators shall be performed by manufacturer representatives of the gas regulators, under actual load conditions. Provide written verification to Engineer

and Owner that all gas pressure regulators are providing the required pressure.
b. Install pressure gage upstream and downstream from each line pressure regulator.

D. Outdoor piping installation:
1. Comply with requirements of Gas Company for all underground service and house piping.
2. Install underground, natural-gas piping buried at least 36 inches below finished grade.
3. Install underground, PE, natural-gas piping according to ASTM D 2774.
4. Fittings, equipment and procedures for making heat fusion joints for PE pipe shall be as recommended by the manufacturer. Each joint in plastic pipe must be made in accordance with the written procedures meeting the requirements of Federal Safety Standards and as adopted by the Gas Company. Qualified personnel shall install all heat fusion joints.
5. Install minimum 10 gauge insulated tracer wire detectable warning tape above the underground service line, 12 inches below finished grade, except 6" below subgrade under pavements, to facilitate location of the pipe after construction. Wire type and termination shall be in accordance with the Gas Company's requirements.
6. The Contractor shall contact the Gas Company providing the service and coordinate all work related to the new gas service.
7. All work shall be provided by the Contractor under supervision of the Gas Company and/or by the Gas Company at the Contractor's expense.
8. The Contractor shall obtain all approved certificates before start of any work; pay all tapping fees, and other charges required by the local authorities.
9. A 6-inch envelope of river sand shall completely surround the underground gas service line at all locations.
10. 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.
a. Install steel pipe for sleeves smaller than 6 inches in diameter.
b. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
11. 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.

E. Inserts:
1. Provide inserts for placement in concrete formwork.
2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

F. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9.
2. Support horizontal piping as indicated.
3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each horizontal elbow.
5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
6. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

a. Painting of exterior piping systems and components is specified in Section 09 9113.

G. Painting of natural gas systems:
1. Painting shall be performed by the contractor installing the gas piping.
2. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars and piping specialties, except components, with factory-applied paint or protective coating. Painting of exterior piping systems and components is specified in Section 09 9113.
a. Alkyd System: MPI EXT 5.1D.
1) Prime Coat: Alkyd anti - corrosive metal primer.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel semi gloss.
4) Color: Yellow or as recommended by the gas company.
3. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, and piping specialties, except components, with factory-applied paint or protective coating. Painting of interior piping systems and components is specified in Section 09 9123.
a. Latex Over Alkyd Primer System: MPI INT 5.1Q.
1) Prime Coat: Alkyd anti - corrosive or Quick-drying alkyd metal primer.
2) Intermediate Coat: Interior latex matching topcoat.
3) Topcoat: Interior latex (flat).
4) Color: Yellow or as recommended by the Utility and Owner.
4. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

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

3.04 APPLICATION

A. Outdoor piping systems:
1. Underground natural-gas piping shall be the following:
a. PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.
2. Aboveground natural-gas piping shall be one of the following:
a. Steel pipe with malleable-iron fittings and threaded joints.
b. Steel pipe with wrought-steel fittings and welded joints.
c. Piping joining methods shall be approved by the supplying gas company.

B. Indoor piping systems for system pressure of .5 PSIG or less:
1. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
2. Steel pipe with malleable-iron fittings and threaded joints.
3. Aboveground, distribution piping shall be one of the following:
a. NPS 2 and Smaller: Steel pipe with malleable-iron fittings and threaded joints.
b. NPS 2 1/2 and Larger: Steel pipe with wrought-steel fittings and welded joints.

C. Indoor piping systems for system pressure of between .5 PSIG and 2 PSIG:
1. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
2. Steel pipe with malleable-iron fittings and threaded joints.
3. Aboveground, distribution piping shall be one of the following:
a. NPS 2 and Smaller: Steel pipe with malleable-iron fittings and threaded joints.
b. NPS 2 1/2 and Larger: Steel pipe with wrought-steel fittings and welded joints.

D. Above Ground Manual Gas Shutoff Valve Schedule:
   1. Valves for pipe sizes NPS 2 and smaller at service meter/ building shutoff, shall be one of the following:
      a. One-piece, bronze ball valve with bronze trim.
      b. Two-piece, full-port, bronze ball valves with bronze trim.
      c. Bronze plug valve.
   2. Valves for pipe sizes NPS 2-1/2 and larger shall be one of the following: Type shall as approved by supplying gas company
      a. Bronze plug valve.
      b. Cast-iron, Nonlubricated plug valve.
   3. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
      a. One-piece, bronze ball valve with bronze trim.
      b. Two-piece, full-port, bronze ball valves with bronze trim.
      c. Bronze plug valve.
   4. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
      a. Bronze plug valve.
      b. Cast-iron, Nonlubricated plug valve.
   5. Valves in branch piping for single appliance shall be one of the following:
      a. One-piece, bronze ball valve with bronze trim.
      b. Two-piece, full-port, bronze ball valves with bronze trim.
      c. Bronze plug valve.

3.05 SCHEDULES

A. Pipe Hanger Spacing:
   1. Metal Piping:
      a. Pipe Size: 1/2 inches to 1-1/4 inches:
         1) Maximum Hanger Spacing: 6.5 ft.
         2) Hanger Rod Diameter: 3/8 inches.
      b. Pipe Size: 1-1/2 inches to 2 inches:
         1) Maximum Hanger Spacing: 10 ft.
         2) Hanger Rod Diameter: 3/8 inch.
      c. Pipe Size: 2-1/2 inches to 3 inches:
         1) Maximum Hanger Spacing: 10 ft.
         2) Hanger Rod Diameter: 1/2 inch.
      d. Pipe Size: 4 inches to 6 inches:
         1) Hanger Rod Diameter: 5/8 inch.

END OF SECTION

SECTION 22 3000
PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Water Heaters:
   1. Commercial gas fired.

B. Diaphragm-type compression tanks.

C. In-line circulator pumps.

D. Pressure booster systems.

E. Sump pumps.
   1. Elevator Sump Pump

1.03 RELATED REQUIREMENTS

A. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.04 REFERENCE STANDARDS

A. ANSI Z21.10.1 - Gas Water Heaters - Volume I - Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less.

B. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels.

1.05 REFERENCE STANDARDS

A. ICC (IPC) - International Plumbing Code, 2015

1.06 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.07 SUBMITTALS

A. Product Data:
   1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Indicate pump type, capacity, power requirements.
   3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
   4. Provide electrical characteristics and connection requirements.

B. Shop Drawings:

C. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

D. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

2. Extra Pump Seals: One of each type and size.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Certifications:
   1. Water Heaters: NSF approved.
   2. Gas Water Heaters: Certified by CSA International to ANSI Z21.10.1, as applicable, in addition to requirements specified elsewhere.
   3. Water Tanks: ASME labeled to ASME BPVC-VIII-1.
   4. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

C. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.

D. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.09 COORDINATION

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

1.10 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.11 WARRANTY

A. Provide five year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.01 COMMERCIAL PACKAGE GAS FIRED WATER HEATING SYSTEMS

A. Manufacturers:
   1. Lochinvar
   2. AO Smith
   3. Larrs
   4. Water heater systems for water heaters other than Lochinvar shall match specifications as listed for Lochinvar. Manufactures listed above that do not meet specifications for Lochinvar in the Engineers opinion; will not be consider an equal.

B. Capacity and Recovery: Refer to schedule on drawings.

C. Commercial, Indirect type, separate heater and storage tank, Condensing, Gas Water Heaters:

D. Manufacturers:
   1. Lochinvar Armor Series
   2. Substitutions: (Equal model, meeting same specifications listed for Lochinvar)

E. Type: Packaged indirect water heater with adjacent storage tank.

F. Water heater shall be Lochinvar Armor. The Water Heater shall be capable of full modulation firing down to 20% of rated input with a turn down ratio of 5:1

G. Water Heater shall bear the ASME "H" stamp and shall be National Board listed for inputs in excess of 200,000 Btu/Hr. There shall be no banding material, bolts, gaskets or "O" rings in the header configuration. The stainless steel combustion chamber shall be designed to drain condensation to the bottom of the heat exchanger assembly. A built-in trap shall allow condensation to drain from the heat exchanger assembly. The complete heat exchanger assembly shall carry a three (3) year limited warranty

H. Water heater shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.10.3 test standard for the US and Canada (500,000 Btu model shall be certified to ANSI Z21.13 as a Hot Water Supply Boiler). The water heater shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard and the minimum efficiency requirements of the latest edition of the ASHRAE 103 Standard. The water heater shall operate at a minimum of 95% thermal efficiency. The water heater shall be certified for indoor installation.

I. The water heater shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided. The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. The water heater shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating water heater firing rates for maximum efficiency. The water heater shall operate in a safe condition at a derated output with gas supply pressures as low as 4 inches of water column.

J. The water heater shall utilize a 24 VAC control circuit and components. The control system shall have an electronic display for water heater set-up, water heater status, and water heater diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The water heater shall be equipped with; an all-bronze circulating pump; sized by the water heater manufacturer, flow switch; high limit temperature control; ASME certified temperature and pressure relief valve; inlet & outlet water temperature sensors; flue temperature sensor; contacts for any failure; runtime contacts; alarm contacts; low water protection and built-in freeze protection (500,000 Btu model shall also be equipped with; a temperature & pressure gauge; high & low gas pressure switches and downstream test cock). The manufacturer shall verify proper operation of the burner, all controls and the heat exchanger by connection to water and venting for a factory fire test prior to shipping.

K. The water heater shall feature the “Smart System” control with a 2-line, 16 character LCD display, password security, pump delay with freeze protection, pump exercise and PC port connection. The water heater shall allow 0-10 VDC input connection for BMS control and have built-in “Cascade” to sequence and rotate while maintaining modulation of up to eight water heaters without utilization of an external controller. Supply voltage shall be 120 volt / 60 hertz / single phase.

L. The water heater shall be provided direct air intake and exhaust. The flue shall be CPVC sealed vent material terminating at the roof with the manufacturers specified vent termination. A separate pipe shall supply combustion air directly to the water heater from the outside. The air inlet pipe shall be PVC or CPVC sealed pipe. The air inlet must terminate on the same sidewall with the manufacturer’s specified vent cap or on the roof, pipe configuratin as recommended by the water heater manufacturer. The water heater’s total combined air intake length shall not exceed 100 equivalent feet. The water heater’s total combined exhaust venting length shall not exceed 100 equivalent feet. Should conditions exist that make the intake and exhaust piping greater than 100 equivalent feet, the water heater manufacturer shall increase the pipe diameter and verify in writing the extended distance will be acceptable to the performance of the heater.

M. The water heater shall have an independent laboratory rating for Oxides of Nitrogen (NOx) of 30 ppm or less, corrected to 3% O2.

N. The water heater firing control system shall be Direct Spark Ignition.

O. Contacts shall be provided in the water heater’s control panel to shut down the water heater in the event the CO detectors in the room go into alarm mode.

P. Storage Tank: Shall be a Lochinvar Lock-Temp with Vertical Construction. The tank shall be constructed in accordance with ASME -stamped and registered with the National Board of Boiler and Pressure Vessel Inspectors. Tank shall have a working pressure of 150 psi, furnished with a handhold, glassed lined, and provided with tank mounted pressure and temperature gauges. Refer to drawings for storage capacity.

Q. Provided with manufacturers published listed features, condensate Neutralization Kit, air inlet & flue exhaust, Concentric Vent Kit

R. Water Heater Accessories.
   1. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.
   2. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.
   3. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.
   4. Combination Temperature and Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select each relief valve with sensing element that extends into storage tank.
      a. Gas Water Heaters: ANSI Z21.22/CSA 4.4.
   5. Pressure Relief Valves: Include pressure setting less than working-pressure rating of water heater.
      a. Gas Water Heaters: ANSI Z21.22/CSA 4.4.
   6. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that is capable of isolating each water heater and of providing balanced flow through each water heater.
   7. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.
   8. Condensate neutralization Kit: As furnished by the water heater manufacturer.
   9. Exhaust piping: CPVC piping: Piping location, configuration shall be installed in accordance with water heater manufactures' recommendations.
   10. Air inlet piping: PVC schedule 40 or CPVC.
   11. Concentric Vent Kit Option: As furnished by the water heater manufacturer for single roof penetration of each individual water heater. Side vented units, if indicated, shall be installed at recommended clearances as shown in water heaters written instructions.

2.02 DIAPHRAGM-TYPE COMPRESSION TANKS / EXPANSION TANKS

A. Manufacturers:
   1. Amtrol Inc
   2. ITT Bell & Gossett
   3. Taco, Inc:
   4. Wessels,Co
   5. Substitutions: See Section 01 6000 - Product Requirements.

B. Construction:
   1. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   2. Welded steel, tested and stamped in accordance with ASME(BPV Vlll,1,supplied with National Board Form U-1, rated for working pressure of 150 psig. with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.
   3. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

4. Air-Charging Valve: Factory installed.

C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psig.

D. Capacity and Characteristics:
   1. Refer to schedule on Drawings.

2.03 IN-LINE MOUNTED CENTRIFUGAL PUMP

A. Manufacturers:
   1. Armstrong Pumps Inc:
   2. ITT Bell & Gossett
   3. Taco,Inc

B. The pumps shall be horizontal, permanently lubricated, specifically designed, and guaranteed for quiet operation. Suitable for 225 degrees F operation at 175 psig working pressure. The pump shall be single stage, vertical split-case design, all bronze construction. The pump internals shall be capable of being serviced without disturbing piping connections.

C. The pump shall be composed of three separable components: a motor, bearing assembly, and pump end (wet end). The motor shaft shall be connected to the pump shaft via a replaceable flexible coupler.

D. The pumps shall have a solid SAE 1144 steel shaft supported by two sealed ball bearings. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.

E. Pumps shall be equipped with an internally flushed mechanical seal assembly. Seal assembly shall have a brass housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.

F. Bearing assembly shaft shall connect to a cast bronze impeller. Impeller shall be both hydraulically and dynamically balanced, keyed to the shaft and secured by a locking cap screw or nut.

G. A flexible-type coupling shall be employed between the pump and motor.

H. Pump should be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.

I. Pump volute shall be cast bronze for domestic water systems. The connection style shall be flanged. Volute shall include gauge ports at nozzles, and vent and drain ports.

J. To ensure alignment, the motor shall be mounted to the bearing assembly via a bolted motor bracket assembly, and a rubber motor mount will be used to assist in aligning the motor shaft with the pump shaft.

K. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors through 1 HP shall be resilient mounted, motors over 1.5 HP shall be rigid mounted. Motors shall have permanently lubricated ball bearings and must be completely maintenance free. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.

L. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts, not press fit components.

M. Pump manufacturer shall be ISO-9001 certified. Pump shall be of U.S. manufacturer.

N. Each pump shall be factory tested and name-plated before shipment.

O. Pump shall have a three-year warranty from date of substantial completion.

P. Refer to schedule on Drawings for Basis of Design.

Q. Pumps Capacities: Not less than indicated on Drawings

2.04 CIRCULATOR PUMP CONTROLS

A. Manufacturers:
   1. Tork:

B. The pumps shall be horizontal, permanently lubricated, specifically designed, and guaranteed for quiet operation. Suitable for 225 degrees F operation at 175 psig working pressure. The pump shall be single stage, vertical split-case design, all bronze construction. The pump internals shall be capable of being serviced without disturbing piping connections.

C. Timers: Electric, for control of each hot-water circulation pump.
   1. Type: Programmable, Electronic Timer, 7 day, indoor use, digital programmable, permanent schedule retention, 9 volt backup battery, manual override on-off switch. Tork Model EW120B or equal as approved by the Professional.
   2. Enclosure: NEMA 250, Type 1. Suitable for wall mounting.
   3. Operation of Pump: On or off.
   4. Transformer: Provide if required.
   5. Power Requirement: 120 V, ac.
   6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days. Coordinate exact control times with Owner

D. Building-automation system interface.
   1. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:
      a. On-off status of each hot water recirculation pump.

2.05 PRESSURE BOOSTER SYSTEMS

A. Manufacturers:
   1. ITT Bell & Gossett:
   2. Flow-Pak
   3. Canarris Corporation
   4. Tiger Flow
   5. Aurora Pumps.

B. Description: Triplex variable speed, variable flow factory assembled domestic water booster system. The unit shall be rated for a system capacity of 390 GPM, with a system pressure of 70 PSI. Minimum suction pressure of 20 PSIG. Maximum suction pressure will be approximately 65 psig. Packaged system shall be Canariis Model TM-390 as represented by Trombold Equipment, Mars,Pa (724) 625-4260 or equal as approved by the Engineer. Refer to schedule on drawings. All components used in the construction of the domestic water booster system shall be “Lead Free” The system shall be provided with three equal pumps. a additional same pump shall be provided as spare and identified as spare.

C. The complete packaged pumping system, including pumps, motors, control equipment, variable frequency drives, valves, fittings and manifolds must be UL Listed. In addition to the UL Listing for the complete system, the control panel assembly must be separately listed under UL-508 Industrial Control Equipment.

D. Valves: Include shutoff valve at each pump suction connection and shutoff valve and check valve at each pump discharge.
   1. Shutoff Valves, NPS 2 and Smaller: MSS SP-110, 600-psig minimum CWP, bronze full port ball valve with ends matching piping.
   2. Shutoff Valves, NPS 2-1/2 and Larger: MSS SP-67, Type I for tight shutoff, 175-psig CWP, single-flanged, cast-iron butterfly valve or full port ball valve
   3. Check Valves, NPS 2 and Smaller: Spring- or lever-loaded, MSS SP-80, Class 125, bronze, swing check valve.

4. Check Valves, NPS 2-1/2 and Larger: Spring- or lever-loaded, MSS SP-71, Class 125, bronze-trim, cast-iron, swing check valve.
5. Valve Class: All valves included in packaged system shall be rated to meet the maximum working pressure in the system.

E. Piping: ASME B31.9 for piping materials and installation.
1. NPS 4 and Smaller: ASTM B 88, Type L, drawn copper water tube; with copper solder-joint pressure fittings, and brazed joints header end connections:
   a. NPS 2 and Smaller: Threaded.
   b. NPS 2-1/2 and Larger: Flanged.
2. Piping Material Option: Welded stainless steel conforming to NSF 61 rating.
3. Piping Option: Piping, including valves and other components, may have grooved ends for grooved joints.

F. Dielectric Fittings: With insulating material isolating joined dissimilar metals to prevent galvanic action and to stop corrosion.
1. NPS 2 and Smaller: Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.
2. NPS 2-1/2 and Larger: Factory-fabricated, companion-flange assembly; for 150- or 300-psig minimum working pressure as required to suit system pressures.

G. Factory Assembly:
1. The booster system shall be factory assembled and tested, mounted on a steel skid, including pumps, motors, valves, 3-inch stainless steel suction and discharge manifolds, all interconnecting piping, wiring, variable frequency drives with logic and power controls.
2. Isolation Valves: Provide isolation valves on the suction and discharge of each pump.
3. Gauges: Provide two 4-1/2” ANSI grade A, panel mounted gauges for indicating system suction and discharge pressure.
4. System Service: Individual pumps, motors, and valves shall be able to be serviced with the booster system in operation, and all components shall be suitable for the maximum working pressure in the system.
5. System Working-Pressure Rating: 175 psig minimum.
6. Factory Paint: All skid-mounted components shall be factory finished in high quality enamel paint.
7. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anti-corrosion compound after assembling and testing. Protect flanges, pipe openings, and pump nozzles.

H. Pumps:
1. System Pumps: System shall include three multi-stage vertical centrifugal pumps with ANSI flanged connections.
   a. Description: The pump suction / discharge chamber, motor stool and pump shaft coupling shall be constructed of cast iron. The impellers, pump shaft, diffuser chambers, outer discharge sleeve and impeller seal rings or seal ring retainers shall be constructed of stainless steel. Intermediate and lower shaft bearings shall be bronze or tungsten carbide and ceramic. Pumps shall be equipped with a mechanical seal assembly with tungsten carbide seal faces mounted in stainless steel seal components. The pump motor shall be NEMA C face design mounted directly to the top of the pump.
2. System Pumps: System shall include three horizontal mounted closed-coupled end suction centrifugal pumps. Model TM-390with ANSI flanged connections. Pump features to include foot supported casing, back pull out design, top centerline discharge and hydraulically balanced impeller. Pump shall be cast iron bronze fitted construction with a replaceable shaft sleeve and mechanical seal suitable for a working pressure of 175 PSIG. Motor shall be NEMA close-coupled type with a JM shaft.

3. Pump Arrangement: Triplex, with three equal-size pumps. pumps.Eachrated 140 GPM at 105 TDH.

I. Motors
   1. Motors shall be Pumps shall be 7.5 HP, 3525 RPM volt, 3 phase, 60 Hz TEFC and manufactured in accordance with NEMA standards. Motors shall be selected so that they do not exceed nameplate HP rating throughout the programmed sequence of pump operation. Motor shall be premium efficiency and suitable for inverter duty / variable speed drive system operation.
   2. Motors shall be ? HP; ???V, 3 phase, 60 Hz TEFC and manufactured in accordance with NEMA standards. Motors shall be selected so that they do not exceed nameplate HP rating throughout the programmed sequence of pump operation. Motor shall be premium efficiency and suitable for inverter duty / variable speed drive system operation.

J. System Valves
   1. Non-slam Check Valves - Each pump discharge shall have a wafer style silent non-slam check valve with cast iron body and sized for a maximum loss of 3 PSI at design flow and be suitable for the maximum working pressure of the system.

K. Variable Frequency Drives:
   1. Description: Provide and mount on the system skid, two variable frequency drives of the PWM design suitable for variable torque applications using any standard NEMA Design B squirrel cage induction motor. Variable frequency drives shall be sized for the maximum possible amp draw throughout the programmed sequence of pump operation. Standard features shall include:
      a. Pulse Width Modulated: Starts into a rotating load.
      b. Keypad Operator Device shall include: 2 line backlit LCD Display. Power on and Alarm / Fault displays. In Auto the drive follows signal from Logic Section of Control Panel. Hand / Off / Auto switch and manual speed adjustment. Auto Drive shutdown for electrical fault. Automatic restart after power fails shutdown Operational data displays shall include: Drive speed (Hz), Motor Power, Energy (kWh), Current, Elapsed Time, RPM, and Motor Voltage. Complete Service Diagnostics with fault history log.
      c. The efficiency at full load and full speed shall be a minimum of 97% with a fundamental power factor of .98.
   2. Variable Frequency Drive Bypasses: Each VFD bypass shall include:
      a. Door interlocked circuit breaker. One motor overload relay. 2 contactor bypass. Drive-off-bypass switch. Drive and bypass pilot lights. UL listed.
   3. Pressure sensor / transmitter: Provide one pressure sensor / transmitter that provides a 4 to 20 mA DC output, compatible with the system controls, temperature and pressure requirements. Pressure sensor / transmitter shall have zero, span and damping devices. The transmitter shall be installed on the system discharge header and factory wired to the control panel.

L. Hydro-pneumatic Tank:
   1. Hydro-Pneumatic Tank: Provide a hydro-pneumatic tank with a carbon steel shell and a replaceable FDA approved heavy-duty bladder to separate the air and water. No water shall come in contact with the metal walls of the tank. Features shall include an air fill valve, pressure gauge connection, and bottom system connection suitable for 100 percent drawdown. A tank must be constructed in accordance with Section VIII of the ASME code and National Board (NB) stamped. Dimensions shall be 30” O.D. x 80” high. The tank shall be rated at 185 gallons - 200 PSIG. The tank shall be mounted adjacent to the pump skid. Tank shall be field painted. The tank feed line shall be connected between each pump discharge and its PRV to provide maximum tank storage. Minimum size of tank feed line shall be 2 inch or as recommended by the booster system manufacturer. Provide

pressure relief valve as recommended by pump system manufacturer on tank feed line, without any valves in line from tank, and pipe to floor drain.

M. Control Panel:
   1. Logic Section:
      a. Provide, mount and wire on the skid a programmable logic controller in a NEMA 1 enclosure to interface the signal from the pressure sensor to the VFD's and provide a stabilized response to speed up or slow down the pump or add the lag pump(s) to meet system requirements.
      b. The controller shall provide set point adjustment, timer adjustment, PID functions and both system and controller self diagnostics via touch screen display. The touch screen display / human machine interface shall include a 5.7" STN display, resistive analog touch, numerical system keyboard. All user interface set points shall be easily accessible via the password protected display screen. Normal system operation shall be tuned to eliminate hunting.
      c. Controller shall have one RS 485 Communication port, real time calendar / clock and EEPROM memory transfer cartridge.
   2. Power Section
      a. Each system shall include a UL listed enclosed industrial control panel in a NEMA 1 enclosure, factory mounted and wired on the steel skid. The panel shall be furnished with individual pump disconnects with through the door handles, pump run lights, H-O-A selector switches and 115 volt fused control transformer
   3. Standard Features:
      a. Control Power (On-Off) Switch and light.
      b. Low suction level shutdown circuit with auto reset and light.
      c. High system pressure shutdown circuit with manual reset and light.
      d. Audible alarm with silence push button.
      e. Auto alternate three equal pumps.
      f. PLC Enable switch.

N. Factory Test:
   1. The complete packaged booster system shall be hydrostatically tested and shall undergo a complete electric and hydraulic test from 0 to 100 percent design flow at the factory. All control devices including remote transmitters and all safety features shall be factory calibrated and tested. At time of testing, contact the Owners representative and invite Owners representative to witness the testing.

2.06 SUBMERSIBLE ELEVATOR SUMP PUMPS

A. Manufacturers:
   1. Zoeller Pump Company:
   2. Stancor, Inc.
   3. Liberty Pumps
   4. Sea Water Control Systems.

B. Description: Factory-assembled and -tested, simplex, package system that will automatically pump water from elevator pits in accordance with ASME A17.1, without danger of ejecting potentially harmful oily substances into storm or sanitary sewers. System shall be a complete package with oil-minder® Control System or approved equal.

C. Features:
   1. NEMA 4x weather tight corrosion resistant fiberglass enclosure.
   2. Stainless steel sensor probe.
   3. Single direct plug-in power source.
   4. Alarm, light, and remote monitoring circuit.
   5. Complete factory packaging insures quality of entire control and pump system.

6. Approved to UL508 and UL778 Standards.
7. ENTELA tested and certified.
8. Lights for oil spill, power, high liquid level, overload, and pump run.
9. Systems utilizing optic sensor will not be considered as a comparable product.

D. Pump Discharge Piping: Factory or field fabricated, ASTM A 53, Schedule 40, galvanized-steel pipe.

E. Capacity and Characteristics:
1. Refer to schedule on Drawings.

F. Building Automation system interface:
1. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:
2. On-off status of each pump.
3. Alarm status.
4. Hydraulic oil spill alert.
5. High liquid condition.

2.07 ELECTRICAL WORK

A. Provide electrical motor driven equipment specified complete with motors, motor starters, controls, and wiring.

B. Electrical characteristics to be as specified or indicated.

C. Furnish motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified.

D. Supply manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices not shown.

PART 3 EXECUTION

3.01 INSTALLATION - GENEAL

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.

B. Pumps:
1. Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.
2. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
3. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.02 GAS WATER HEATER INSTALLATION

A. Install water heaters in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible

B. Coordinate with plumbing piping and related gas venting and electrical work to achieve operating system.

C. Install commercial water heaters on concrete bases.

D. Install gas water heaters according to NFPA 54.

E. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.

F. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.

G. Install automatic gas valves on gas supplies to gas water heaters, if required for operation of safety control.

H. 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.

I. 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 water heaters that do not have tank drains.

J. Install thermometer on outlet piping of water heaters. Refer to Section 220519 "Meters and Gages for Plumbing Piping" for thermometers.

K. Install pressure gage(s) on inlet and outlet piping of commercial, fuel-fired water heater piping. Refer to Section 220519 "Meters and Gages" for pressure gages.

L. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet.

M. Install air inlet and exhaust assemblies in accordance with manufacturer’s written instructions. Terminate each water heater with concentric vent kit, installed in accordance with manufacturer’s written instructions.

N. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

O. 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 to Owner and Engineer.

P. Demonstration:Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water heaters.

3.03 WATER BOOSTER SYSTEM INSTALLATION

A. Install water booster system in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

B. Install booster system and hydro-pneumatic tank on concrete bases.

C. Support connected domestic-water booster piping so weight of piping is not supported by booster pumps.

D. Install suction and discharge pipe equal to or greater than size of system suction and discharge headers.

E. Install union, flange, or grooved-joint connections on suction and discharge headers at connection to domestic water piping.

F. Install valved bypass with check valve, same size as suction and discharge piping.

G. Install separate pressure gauges on inlet and outlet of pumping package.

H. Install pressure relief valve in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend 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.

I. 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 to Owner and Engineer.

J. Startup Service:
   1. Engaged a factory-authorized service representative to perform startup service.
      a. Complete installation and startup checks according to manufacturer's written instructions.

K. Demonstration:
   1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain booster pumps.

L. Occupancy adjustments:
   1. When requested by Owner, within 12 months of date of System Startup, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.04 CIRCULATOR PUMP INSTALLATION

A. Install circulator pumps in accordance with manufacturer's instructions, as required by code.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Install in-line circulators, in-line mounted centrifugal pumps with motor and pump shafts horizontal.

E. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and elastomeric hangers of sufficient size to support pump weight.

F. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

G. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping.

H. Install thermometers on pump suction line of each pump and circulator.

I. Control:
   1. Control pumps to operate with time clock and manual power shutoff.
   2. Coordinate connection to the building management system with the temperature control contractor.

J. Furnish and deliver to Electrical Contractor for installation for each single phase pump, one thermal switch.

K. Furnish and deliver for installation in connection with each pump that has a three-phase motor, one combination fusible disconnect switch and magnetic starter with three overload relays and “Hand-Off-Automatic” switch. Magnetic starters shall have NEMA Type 1 enclosures and shall provide overload protection and low voltage release and be similar to Square D, Class 8539, or equal as approved by Engineer. Disconnect switches shall be provided with three Class ‘R’

rejection type Fusetron fuses sized in accordance with the fuse manufacturer's recommendations. Disconnect switches and starters shall be attached to pump or properly tagged in shipment to indicate pump with which they should be installed

L. Startup Service:
   1. Engaged a factory-authorized service representative to perform startup service.
      a. Complete installation and startup checks according to manufacturer's written instructions.
      b. Complete installation and startup checks according to manufacturer's written instructions.
      c. Check piping connections for tightness.
      d. Clean strainers on suction piping.
      e. Perform the following startup checks for each pump before starting:
         1) Verify bearing lubrication.
         2) 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.
         3) Verify that pump is rotating in the correct direction.
      f. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
      g. Start motor.
      h. Open discharge valve slowly.
      i. Adjust temperature settings on thermostats.
      j. Adjust timer settings.

M. Demonstration:
   1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain circulator pumps.

N. Adjusting:
   1. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.
   2. Adjust initial temperature set points.
   3. Set field-adjustable time clocks to owners' preference

O. Occupancy adjustments:
   1. When requested by Owner, within 12 month's of date of System Startup, provide on-site assistance in adjusting circulator pump to suit actual occupied conditions. Provide up to two visits to Project for this purpose.

3.05 ELEVATOR SUMP PUMP INSTALLATION

A. Install elevator sump pump(s) in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.

B. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.

C. Set submersible sump pumps on pit floor. Make connections to drainage piping.

D. Install sump pump basins where indicated. Brace interior of basins according to manufacturer's written instructions to prevent distortion or collapse during concrete placement. Set basin cover and fasten to basin top flange. Install cover so top surface is flush with finished floor.

E. Support piping so weight of piping is not supported by pumps.

F. Refer to detail on drawings

G. Elevator Sump Pump Installation:
   1. Pump On: Pump goes on with water in contact with sensor probe.

2. Pump On: Pump continues to pump water down.
3. Pump On / Pump Off: Pump will continue to run, pumping water only until:
   a. Water level drops below tip of sensor probe or
   b. Only oil is in contact with sensor probe, eliminating electrical conductivity.
4. Pump Off: Pump shuts off before oil is pumped, leaving approximately 3 inches of liquid in bottom of sump.
5. Pump Off: Sump floods with oil, sensor probe overrides pump switch and pump remains off. (oil is contained) If the water level in the elevator pit increases, the oil (which is lighter than water) will rise above the oil-sensing probe and allow the pump to function in a normal manner, until the water is pumped down and oil, once again, comes into contact with the probe.

H. Startup Service: Engaged a factory-authorized service representative to perform startup service.

I. Demonstration:Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls of elevator sump pumps.

END OF SECTION

SECTION 22 4000
PLUMBING FIXTURES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Supplies and stops.
B. Traps.
C. Flow control devices.
D. Protective shielding guards
E. Water closets.
F. Urinals.
G. Lavatories.
H. Sinks.
I. Laboratory sinks.
J. Service sinks.
K. Commercial Kitchen Sinks.
L. Electric water coolers.
M. Bathtubs.
N. Showers.

1.03 RELATED REQUIREMENTS

A. Section 07 9200 - Joint Sealants: Sealing joints between fixtures and walls and floors.
B. Section 11 4000 - Foodservice Equipment: Food service sinks.
C. Section 12 3600 - Countertops: Preparation of counters for sinks and lavatories.
D. Section 22 1005 - Plumbing Piping.
E. Section 22 1006 - Plumbing Piping Specialties.
F. Section 22 3000 - Plumbing Equipment.
G. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.04 REFERENCE STANDARDS

A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design.
B. ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures.
C. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment.
D. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
E. ASME A112.18.1 - Plumbing Supply Fittings.
F. ASME A112.19.1 - Enamelled Cast Iron and Enamelled Steel Plumbing Fixtures.
G. ASME A112.19.2 - Ceramic Plumbing Fixtures.
H. ASME A112.19.3 - Stainless Steel Plumbing Fixtures.

I. ASME A112.19.4M - Porcelain Enameled Formed Steel Plumbing Fixtures.

J. ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks.

K. ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices.

L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

M. NSF 61 - Drinking Water System Components - Health Effects.

N. NSF 372 - Drinking Water System Components - Lead Content.

1.05 SUBMITTALS

A. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

B. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Source limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1.07 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

B. All components in contact with the domestic water piping system shall be Lead Free: Lead free refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average content less than 0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Accept fixtures on site in factory packaging. Inspect for damage.

B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.09 WARRANTY

A. Provide five year manufacturer warranty for electric water cooler.

B. Provide five year manufacturer warranty for all flush valves (batteries excluded on all sensor flush valves)

C. Provide five year manufacturer warranty for all faucets. (Batteries are excluded for sensor faucets).

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 REGULATORY REQUIREMENTS

A. Comply with applicable codes for installation of plumbing systems.

B. Perform work in accordance with local health department regulations.

C. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of installation.

2.03 SUPPLIES AND STOPS

A. Manufacturers:
   1. McGuire Manufacturing Company, Inc. Cheshire, CT, Premiere Line
   2. Chicago Faucets, Des Plaines, IL
   3. Zurn Commercial heavy duty line.

B. General: Each lavatory, and sink shall be provided with chrome plated, commercial pattern quarter-turn brass ball valve with convertible loose key handle, (chrome platted copper or braided stainless risers) and forged brass escutcheon flange with set screw. 1/2" IPS chrome plated nipple. Inlet shall be 1/2" IPS, Outlet shall be 3/8" compression. Supply kit shall be McGuire BV2165.

C. ADA Compliant Lavatory and normal wall hung lavatory: Provide ADA compliant, “Lav Shield” Covering on all supplies, stops, and risers. In-line Thermostatic mixing valve for all public lavatories and all lavatories provided with automatic sensors for flow control.

D. ADA Compliant Sink, counter lavatory: Provide ADA compliant, PVC ProWrap Covering on all supplies, stops, and risers, as manufactured by McGuire or equal as approved by the Engineer. In- line Thermostatic mixing valve for all public lavatories and all lavatories provided with automatic sensors for flow control.

E. Each drinking fountain and/or water cooler shall be provided with chrome plated copper heavy duty brass angle stops, 3/8-inch I.P.S. by 3/8-inch O.D., with wheel handle stops, 1/2-inch chrome plated nipple, chrome plated setscrew type brass wall escutcheon. McGuire Model HST01 or equal as approved by the Engineer.

F. Supplies and stops other than McGuire, Premiere Line shall have project cross-reference on McGuire’s cross-reference index, provided with review submittal.

G. Food Service Areas: Sinks and items requiring water supplies in food services areas where sinks and equipment is provided by the Food service Contractor, shall be provided with supplies as specified above, except with 1/2-inch flexible risers and wheel handle stops. Provide in-line Thermostatic mixing valve for all kitchen hand sinks.

2.04 TRAPS

A. Manufacturers:
   1. McGuire Manufacturing Company, Inc., Cheshire, CT.
   2. Brasscraft, Commercial Line
   3. Kohler, WI. Commercial Line
   4. Zurn, Commercial Line

B. Non ADA Trap: 17 gauge, 1-1/4-inch by 1-1/2-inch outlet, Vandal-Resistant, cast brass chrome P-trap with cleanout plug. Brass friction inlet, cast brass slip nuts, 17 gauge seamless tubular wall bend and box flange. McGuire Model V8902C or approved equal. Provide ProWrap®, anti-microbial on all handicap fixtures as manufactured by McGuire, Inc., Premier Line, or equal as approved by the Engineer.

C. ADA Compliant Trap: 17 gauge, 1-1/4-inch by 1-1/2-inch outlet, offset assembly, provided with pre-wrapped trap, vandal-resistant, cast brass chrome P-trap with cleanout plug. Brass friction inlet, cast brass slip nuts, 17 gauge seamless tubular wall bend and box flange. McGuire Model PWV8902CWC or equal as approved by the Engineer.

D. All vitreous china wall hung lavatories: ADA Compliant full covering “Lav Shield” as manufactured by Turebro, or equal as approved by the Professional. All units shall be factory

pre-cut for each specified plumbing fixture. No field cutting permitted.

2.05 FLOW CONTROL DEVICES

A. Available Manufacturers:
   1. Chronomite Laboratories, Inc., Omni® Faucet, Harbor City, CA. or equal

B. Type: In-line flow control, GPM as noted under individual fixture, exact type to match particular faucet.

2.06 PROTECTIVE SHIELDING GUARDS

A. Manufacturers:
   1. Brocar Products, Cincinnati, OH
   2. Truebro, Inc., Ellington, CT
   3. McGuire, Cheshire, CT

B. Protective Shielding Guard: Manufactured plastic enclosure for covering hot- and cold-water supplies and trap and drain piping, anti-microbial and complying with ADA requirements.

C. Refer to individual fixture for style and type.

D. Required on all handicapped designated fixtures.

2.07 FLUSH VALVE WATER CLOSET W-1

A. Water Closets: Vitreous china, ASME A112.19.2, wall hung, siphon jet flush action 1.6 gallons per flush
   1. Bowl: 15"high with elongated rim.
   2. Flush Valve: Exposed (top spud).
   3. Flush Operation: Sensor operated.
   4. Color: White.
   5. Manufacturers:
      a. American Standard, Inc:
      b. Kohler Company; Model K-4325:
      c. Zurn Industries, Inc:
      d. Sloan,Model ST-2053-1.6

B. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories. 1.6 gpf.
   1. Sensor-Operated Type: Solenoid operator, battery powered, infrared sensor with over-ride push button.
   2. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop, seat bumper, supply tube support ring.
   3. Manufacturers:
      a. Sloan Valve Company; Model G2 8111 with manual override:
      b. Zurn Industries, Inc; Model AquaVantage ZER6000-CPM-WS-1-YK-YO:
      c. Moen -8300 Series Combination Manual / Automatic Sensor,and Manual Override.

C. Seats:
   1. Manufacturers:
      a. American Standard, Inc
      b. Beneke
      c. Bemis Manufacturing Company
      d. Church Seat Company
      e. Olsonite
   2. Solid white plastic, commercial grade, open front, extended back, self-sustaining hinge, brass or stainless steel bolts, without cover.

a. Provided with Just-Lift® StaTite® Commercial Fastening System as manufactured by Church or Bemis.

D. Water Closet Carriers:
1. Manufacturers:
a. JOSAM Company
b. Jay R. Smith
c. Zurn Industries, Inc
2. ASME A112.6.1M; adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers. Heavy Duty rated closet carrier.

2.08 FLUSH VALVE WATER CLOSET W-1,HC

A. Water Closets: Vitreous china, ASME A112.19.2, wall hung, siphon jet flush action Same as specified for W-1, except mounted at handicapped height.

2.09 WALL HUNG URINAL U-1

A. Wall Hung Urinal Manufacturers:
1. American Standard, Inc; WASHBROOK Urinal
2. Kohler Company; Model Bardon K-4904-ER
3. Zurn Industries, Inc
4. Sloan Model SU-1005-0.5.

B. Urinal: Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier.
1. Flush Volume: 0.5 gallons, maximum.
2. Flush Style: Washout.
3. Flush Valve: Exposed (top spud).
4. Flush Operation: Sensor operated.
5. Trap: Integral.
6. Removable stainless steel strainer.
7. Supply Size: 3/4 inch.
8. Outlet Size: 2 inches.

C. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories. .50 gpf.
1. Sensor-Operated Type: Solenoid operator, battery powered, infrared sensor with mechanical over-ride or over-ride push button.
2. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.
3. Manufacturers:
a. Sloan Valve Company; Model G2 8180-1.0
b. Zurn Industries, Inc; Model AquaSense AV ZER6003-AV-EWS
c. Moen 8315 Series Combination Manual / Auto Sensor.

D. Carriers:
1. Manufacturers:
a. Jay R. Smith
b. Zurn Industries
2. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.10 WALL HUNG URINAL U-1,HC

A. Urinal: Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier. Same as specified for U-1, except mounted at handicapped height.

B. Carriers:

1. Manufacturers:
    a. JOSAM Company
    b. Jay R. Smith
    c. Zurn Industries, Inc
2. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.11 LAVATORIES L-1,HC

A. Lavatory Manufacturers:
    1. American Standard, Inc:
    2. Kohler Company; Model K-2005:
    3. Zurn Industries, Inc:
    4. Sloan .

B. Vitreous China Wall Hung Basin: ASME A112.19.2,vitreous china wall hung lavatory. 18 inch by 21 inch with minimum 4 inch high back, rectangular basin with splash lip, front overflow, and soap depression.
    1. Drilling Centers: 4 inch.

C. Supply Faucet Manufacturers:
    1. Chicago Faucet
    2. Moen Commercial Model
    3. T&S Brass EC-3142-VF05
    4. Zurn Model

D. Faucet:
    1. Faucet: Chrome plated Brass Above Deck Electronic Faucet, Single Hole Deck Mount, 4" chrome plated brass deck plate. VR 0.5 GPM Non-Aerated Spray Device, Above Deck Temperature Control, Battery or AC adapter Powered, Stainless Steel Flexible Supply Hoses & 3/8" Compression inlets. Faucet shall meet ADA ANSI/ICC A117.1 requirements and be tested and certified to industries standards: ASME A112.18.1 / CSA B125.1 and certified to NSF/ANSI 61, Section 9 by CSA. NSF / ANSI 372 Low Lead Content, UL 1951. Faucets shall have a five year manufacturer warranty on the entire faucet. T&S Brass Model EC-3142-VF05 or approved equal.

E. Accessories:
    1. Chrome plated 17 gage, 0.0538 inch brass P-trap with clean-out plug and arm with escutcheon.
    2. Screwdriver stops as specified herein.
    3. Rigid supplies as specified herein.
    4. Thermostatic Mixing Valve: In-line thermostatic mixing valve, meeting ASSE 1070 for "Point of Use" individual temperature control applications. Leonard model 170A-LF. or approved equal.
    5. Supply and drain covering: ADA compliant solid one piece full lavatory protective shield as manufactured by Turebro. "Lav Shield". Anti-microbial.
    6. Carrier:
        a. Manufacturers:
            1) JOSAM Company
            2) Zurn Industries, Inc
            3) J.R. Smith.
        b. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, bearing plate and studs.

2.12 LAVATORIES L-2, L-2,HC

A. Lavatory Manufacturers:

1. American Standard, Inc:
2. Kohler Company; Model K-R2196-4:
3. Zurn Industries, Inc:
4. Sloan Model SS-3002.

B. Vitreous China Counter Top Basin: ASME A112.19.2; vitreous china self-rimming counter top lavatory, 24-1/4 inch by 17-1/2 inch oval with drillings on 4 inch centers, front overflow, soap depression, seal of putty, calking, or concealed vinyl gasket.

C. Supply Faucet Manufacturers:
1. Chicago Faucet
2. Moen Commercial Model
3. T&S Brass Model EC-3142-VF05
4. Zurn Model

D. Supply Faucet
1. Faucet: Chrome plated Brass Above Deck Electronic Faucet, Single Hole Deck Mount, 4" chrome plated brass deck plate. VR 0.5 GPM Non-Aerated Spray Device, Above Deck Temperature Control, Battery or AC adapter Powered, Stainless Steel Flexible Supply Hoses & 3/8" Compression inlets. Faucet shall meet ADA ANSI/ICC A117.1 requirements and be tested and certified to industries standards: ASME A112.18.1 / CSA B125.1 and certified to NSF/ANSI 61, Section 9 by CSA. NSF / ANSI 372 Low Lead Content, UL 1951. Faucets shall have a five year manufacturer warranty on the entire faucet. T&S Brass Model EC-3142-VF05 or approved equal.

E. Accessories:
1. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
2. Screwdriver stops as specified herein.
3. Rigid supplies as specified herein.
4. Thermostatic Mixing Valve: In-line thermostatic mixing valve, meeting ASSE 1070 for "Point of Use" individual temperature control applications. Leonard 170A-LF or approved equal.

2.13 SINK S-1,HC

A. Sink Manufacturers:
1. Elkay Manufacturing Company, Lustertone Series Model LRAD-1918
2. Just Manufacturing Company
3. Sterling Plumbing Group, Inc
4. Advance Tabco

B. Single Compartment Bowl: ASME A112.19.3; Overall 19 inches by 18 inches; Inside 16 inches by 11-1/2 inches, 5-1/2" deep. 18 gauge, type 304 (18-8) nickel bearing stainless steel, self-rimming, fully undercoated.
1. Drain: 1-1/2-inch by 1-1/2" chrome plated with cast brass P-trap, waste to wall, wall escutcheon, as specified under traps.
2. Drain Location: Off-Centered rear.
3. Drain and Supply Pipe Covering: Manufactured plastic drain and pipe covering complying with ADA requirements. TrueBro lavatory protective enclosure. Anti-microbial.
4. Faucet Holes: Three holes on 4-inch centers.
5. Supplies: Chrome plated copper with stops as specified under lavatory supplies and stops.
6. Thermostatic Mixing Valve: In-line thermostatic mixing valve, meeting ASSE 1070 for "Point of Use" individual temperature control applications.

C. Faucet Manufacturers:
1. Chicago Faucet

2. Moen Commercial
3. T&S Brass
4. Zurn

D. Faucet:
1. Faucet: Single hole deck mount electronic sensor faucet with polished chrome plated brass body and 7-1/16" surgical bend gooseneck 1.0 GPM vandal resistant laminar flow device, AC / DC control module with internal flow control setting switches, temperature control mixing valves with check valves, 18" flexible stainless steel supply hoses, with 3/8" compression connections. Certified to ASME A112.18.1 / CSA B125.1,NSF 61-Section 9-NSF 372 and UL 1951 and shall meet ADA ANSI / ICC A117.1 requirements. T&S model EC-3100-LF22-SB or approved equal.

2. Thermostatic Mixing Valve: In-line, meeting ASSE 1070 for "Point of Use" individual temperature control applications. Leonard Model 170A-LF or approved equal.

2.14 LABORATORY SINK LS-1,HC

A. Sink Manufacturers:
1. Elkay Manufacturing Company, Lustertone Series Model LRAD-1918
2. Just Manufacturing Company
3. Sterling Plumbing Group, Inc
4. Advance Tabco

B. Single Compartment Bowl: ASME A112.19.3; Overall 19 inches by 18 inches; Inside 16 inches by 11-1/2 inches, 5-1/2" deep. 18 gauge, type 302 (18-8) nickel bearing stainless steel, self-rimming, fully undercoated.
1. Drain: 1-1/2-inch by 1-1/2" chrome plated with cast brass P-trap, waste to wall, wall escutcheon, as specified under traps.
2. Drain Location: Off-Centered rear.
3. Drain and Supply Pipe Covering: Manufactured plastic drain and pipe covering complying with ADA requirements. TrueBro lavatory protective enclosure. Anti-microbial.
4. Faucet Holes: One centered.
5. Supplies: Chrome plated copper with stops as specified under lavatory supplies and stops.

C. Faucet Manufacturers:
1. Chicago Faucet
2. Moen Commercial
3. T&S Brass
4. Zurn

D. Faucet:
1. Faucet: Single hole deck mount electronic sensor faucet with polished chrome plated brass body and 7-1/16" surgical bend gooseneck 2.2 GPM vandal resistant laminar flow device, AC / DC control module with internal flow control setting switches, temperature control mixing valves with check valves, 18" flexible stainless steel supply hoses, with 3/8" compression connections. Certified to ASME A112.18.1 / CSA B125.1,NSF 61-Section 9-NSF 372 and UL 1951 and shall meet ADA ANSI / ICC A117.1 requirements. T&S model EC-3100-LF22-SB or approved equal.

2. Thermostatic Mixing Valve: In-line, meeting ASSE 1070 for "Point of Use" individual temperature control applications. Leonard Model 170-LF or approved equal.

2.15 SERVICE SINK SS-1

A. Sink Manufacturers:

1. Fiat Products, Plainview, NY
2. Precast Terrazzo Enterprises, Inc
3. Stern Williams Co. Corlow Model SBC-1750. T35-T40-BP

B. Floor mounted service sink.
1. Construction: One-piece precast terrazzo 6-inch front drop with stainless steel cap made of marble chips cast in gray Portland cement with compressive strength of not less than 3,000 PSI seven day after casting. Surface shall be ground and polished with air holes and pits grouted, with excess removed. Stern Williams Corlow® Model SBC-1750 size 36 inches by 36 inches by 12 inches, with or without tiling flange as required..
2. Trim: Stainless steel strainer with vandal proof screws cast integral. Stainless steel protective cap on front drop. Splash catcher panels, stainless steel. Mop hanger. Hose and wall hook, coordinated exact location with other trades. All screws for splash panels and mop hanger assemblies shall be secured with vandal proof fasteners.

C. Faucet Manufacturers:
1. Chicago Faucet
2. T&S Brass

D. Faucet:
1. 8" Wall mounted hot and cold water service sink faucet. Polish chrome plated brass spout, vacuum breaker, pail hook and 3/4" male hose thread, wall brace, metal lever handles. Rebuildable compression cartridges with spring checks, offset supply arm with integral check and shut-off stop. Spill resistant pressure vacuum breaker for continuous pressure applications. Secondary control valve. T&S Model B-0665-BSTP-963 or approved equal. Attached to wall with vandal proof fasteners.

2.16 SERVICE SINK SS-2

A. Sink Manufacturers:
1. Elkay Manufacturing Company, Model ESSW-2520
2. Just Manufacturing Company
3. Sterling Plumbing Group, Inc
4. Advance Tabco

B. Type: Wall mounted, 14 gauge, Type 304 stainless steel with 1-3/4-inch radius vertical and horizontal covered corners, 1-1/2-inch rolled rims. Full-length backsplash. All exposed surfaces blended to uniform satin luster finish. Furnished with wall hanger and stainless steel support brackets, cast iron P-trap and drain, Elkay Model ESSW 2520.
1. Size: 25 inches by 19-1/2-inches.
2. Drain Location: Centered with grid strainer drain assembly and tailpiece.
3. Faucet Holes: None.

C. Faucet:
1. Faucet: 8" Wall mounted hot and cold water service sink faucet. Polish chrome plated brass spout, vacuum breaker, pail hook and 3/4" male hose thread, wall brace, metal lever handles. Rebuildable compression cartridges with spring checks, offset supply arm with integral check and shut-off stop. Spill resistant pressure vacuum breaker for continuous pressure applications. Secondary control valve. T&S Model B-0665-BSTP-963 or approved equal. Attached to wall with vandal proof fasteners.

2.17 SERVICE SINK SS-3

A. Sink Manufacturers:
1. Elkay Manufacturing Company,
2. Just Manufacturing Company
3. Sterling Plumbing Group, Inc
4. Advance Tabco

B. Type: Floor mounted, 16 gauge, Type 304 stainless steel. All exposed surfaces blended to uniform satin luster finish. Elkay Model EFS3321C-LK43. or approved equal.
   1. Size: 33 inches by 21" x 8-inches overall.Inside 28" x 16" 8". With tiling flange. Location and quantity as required.
   2. Drain Location: Centered with grid strainer drain assembly and tailpiece.
   3. Faucet Holes: None.

C. Faucet:
   1. 8" Wall mounted hot and cold water service sink faucet. Polish chrome plated brass spout, vacuum breaker, pail hook and 3/4" male hose thread, wall brace, metal lever handles. Rebuildable compression cartridges with spring checks, offset supply arm with integral check and shut-off stop. Spill resistant pressure vacuum breaker for continuous pressure applications. Secondary control valve. T&S Model B-0665-BSTP-963 or approved equal. Attached to wall with vandal proof fasteners.

2.18 COMMERCIAL KITCHEN SINKS

A. Kitchen Sink, KS-1 .
   1. Furnished by Food Service Contractor.
   2. All final connections by Plumbing Contractor.
   3. Supplies and stops as specified herein.
   4. Chrome plated tail piece extension, P-Trap were required.

B. Kitchen Sink KS-1T
   1. Furnished by Food Service Contractor.
   2. Provide in-line thermostatic mixing valve in hot water supply line.
   3. All final connections by Plumbing Contractor.
   4. Supplies and stops as specified herein.
   5. Chrome plated tail piece extension, P-Trap where required.
   6. Mixing Valve Thermostatic; ASSE 1070 for "Point of Use" individual control applications. Leonard Model 170A-LF or approved equal.

2.19 BATHTUB BT-1,HC

A. Bathtub Manufacturers:
   1. American Standard, Inc: www.americanstandard-us.com/#sle.
   2. Comfort Design: Model XSS 6092 TS
   3. Kohler Company: www.kohler.com/#sle.

B. Bathtub: ANSIZ 124.1.2,ADA Cpmpliant; One-piece sanitary grade AcrylX applied acrylic. The base shall be attached to the sump to form an integral part with an inner and outer coating of polyester resin. Unit construction shall be of molded reinforced fiberglass with 15% minimum fiberglass content.
   1. Length: 60 inches.
   2. Width: 32-1/4 inches.
   3. Height 77-1/2 inches

C. Bath and Shower Trim: ASME A112.18.1; concealed shower and over rim supply with diverter spout, pressure balanced mixing valve, bent shower arm with flow control and adjustable spray ball joint showerhead with maximum 2.5 gallons per minute flow and escutcheon as manufactured by Symmons or approved equal. Lever operated pop-up waste and overflow. HDPE folding seat, ADA compliant grab-bars on side and control side. Flex hand held shower arm with vacuum breaker. Integral full wood backing for strength and unlimited accessory placement. One inch diameter, 18 gauge white curtain rod with receiver cups. Grab bars shall be as follows:
   1. Two 24" x 1-1/4" diameter white on flange horizontal grab bars on the back wall.
   2. Two 24" x 1-1/4" diameter white no flange horizontal grab bars one on each side wall.

3. One 24" x 1-1/4" diameter no flange vertical grab bars on the valve wall.
4. All grab bars shall have 1-1/2" statute clearance, mounted with stainless steel bolts, and secured from the rear with 3" x 3" x 11 gauge metal mounting plates.

2.20 SHOWERS CSH-1,HC

A. Shower Manufacturers:
   1. Comfort Design Model: XSS 3698 BF .625 - R/L
   2. Aqua Glass Corporation: www.aquaglass.com/#sle.
   3. Kohler Company: www.kohler.com/#sle.

B. Shower Cabinet: ANSI Z124.1.2,ADA Compliant; Cabinet: Right or Left as required. One-piece sanitary grade AcrylX applied acrylic . The base shall be attached to the sump to form an integral part with an inner and outer coating of polyester resin. Unit construction shall be of molded reinforced fiberglass with 15% minimum fiberglass content. Outside dimensions:
   1. 42 inches x 37-1/2" x 82"

C. The shower enclosure shall be provided with the following:
   1. One 18" x 33-1/2" x 1-1/4" diameter 18 gauge stainless steel L-grab bar.
   2. One 24" x 1-1/2" diameter 18 gauge stainless steel vertical grab bar.
      a. Grab bars shall be installed with 1-1/2" statute clearance, secured from the rear with stainless steel bolts and 3" x 3" x 11 gauge metal mounting plates.
   3. 32" x 21" Frameless white HDPE fold-up seat.
   4. 1" diameter stainless steel curtain rod with receiver cups.
   5. Recessed receiver flange on both sides.
   6. Factory installed Easy Base self sustaining bottom.
   7. 5/8" threshold.

D. Shower Valve:
   1. Comply with ASME A112.18.1.
   2. Symmons Hand Held Shower System: Model 9603-PLR-1.5-X, complete with check stops, vacuum breaker, hand held shower assembly with side bar and 60-inch hose, ADA compliant, 1.50 gpm flow restrictor or equal
   3. Shower Valve Manufacturers:
      a. American Standard, Inc: www.americanstandard-us.com/#sle.
      b. Symmons
      c. Substitutions: See Section 01 6000 - Product Requirements.

2.21 ELECTRIC WATER COOLERS

A. Electric Water Cooler Manufacturers:
   1. Tri Palm International/Oasis
   2. Elkay Manufacturing Company
   3. Haws Corporation
   4. Oasis International:

B. Water Cooler DD-2,HC
   1. Description: ARI 1010, accessible ADA compliant, wall hanging split-level water cooler, Sports bottle fill, lead-free in materials and construction. No CFC's.
   2. Cabinet: All stainless steel with refrigerated compartment in front panel.
   3. Bubbler: One, with adjustable stream regulator, located on deck, vandal resistant, Filtration system.
   4. Control: Front and side Push buttons. Silver-vased antimicrobial.
   5. Supply: NPS 3/8 with ball valve.
   6. Filter: One or more 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.

7. Bottle filler-Sports bottle Filler, located on lower unit, with independent manual activation.
8. Drain: Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2.
9. 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. Refrigerant R-134a.
    a. Capacity: 8.0 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
10. Electrical Characteristics: 1/5 hp; 120-V ac; single phase; 60 Hz
11. Model: Oasis PG8SBFSL with one piece vandal resistant bubbler, Oasis green filtration system or approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.02 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall supports and bolts.

E. Provide fresh name brand batteries, type as recommended by faucet manufacturer in all battery powered faucets and flushvalves.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

B. Adjust water pressure at faucets, shower valves and flushometer valves to produce proper flow and stream.

C. Adjust water stream height at all water cooler in accordance with ADA requirements.

D. Adjust limit stops on all shower valves after the water's master thermostatic mixing valve has been calibrated and set.

3.06 CLEANING

A. Clean fixtures, faucets and other fittings with manufacturers' recommended cleaning methods and materials. Inspect all exposed finishes and repair damaged finishes.

B. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.

C. Remove sediment and debris from drains.

3.07 PROTECTION

A. Protect installed products from damage due to subsequent construction operations.

B. Do not permit use of fixtures by construction personnel.

C. Repair or replace damaged products before Date of Substantial Completion.

3.08 SCHEDULES AND MOUNTING HEIGHTS

A. Fixture Heights: Installed fixtures to heights above finished floor as indicated on the Architectural Drawings.

B. Fixture rough-in sizes: Refer to fixture rough-in schedule on the Plumbing Drawings.

END OF SECTION

SECTION 22 4600
SECURITY PLUMBING FIXTURES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. This Section includes the following security plumbing fixtures and related components:
   1. Combination units.
   2. Lavatories.
   3. Showers.
   4. Urinals.
   5. Water closets.
   6. Detox Toilet
   7. Fixture supports for front-mounting, stainless-steel fixtures.
   8. Security fixtures for installation by pre-cast cell contractor.
   9. Electrically operated ball valve for gang shower control.

1.03 RELATED REQUIREMENTS

A. Section 07 9005 - Joint Sealers: Seal fixtures to walls and floors.

B. Section 22 1005 - Plumbing Piping.

C. Section 22 1006 - Plumbing Piping Specialties.

D. Division 13 Section "precast-Concrete Detention Cell Modules"

1.04 DEFINITIONS

A. Accessible Fixture: Security plumbing fixture that can be approached and used by people with disabilities.

B. Back-Mounting-Type Fixture: Security plumbing fixture designed to mount on wall sleeve built into wall so installation and removal of fixture and piping and other components are only accessible from service space behind wall.

C. Front-Mounting-Type Fixture: Security plumbing fixture designed to mount on fixture support with installation and removal from fixture side of wall, and piping and other components are accessible from access panels in fixture or wall.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated. Include furnished specialties and accessories.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For security plumbing fixtures to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

A. 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"; about security plumbing fixtures for people with disabilities.

B. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

C. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

D. Provide components and fixtures from single manufacture source.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Flushometer Valves: Equal to 10 percent of amount installed for each type indicated, but no fewer than 10 units.
   2. Mechanical and Air-Operated Valves: Equal to 10 percent of amount installed for each type indicated, but no fewer than 10 units.

1.08 MOCKUP

A. Provide mockup of typical cell chase and shower chase at housing units under provisions of Division 01.

B. Mockup may remain as part of the Work.

C. Plumbing Contractor shall first begin his mockup and then turn over to the HVAC, Sprinkler, and Electrical Contractors for coordination. Mockup shall include all items necessary for final finished product.

PART 2 PRODUCTS

2.01 SECURITY COMBINATION UNITS

A. Security Combination Units, P-1: (Furnished as part of Pre-Cast package)
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Engineering Company.
      b. Metcraft Industries Inc.
      c. Willoughby Industries, Inc.
   2. Description: Back-mounting, Centered toilet bowl -cabinet, security plumbing fixture with integral water closet and lavatory; fabricated from 14 gauge thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
   3. Combination Lav/Toilet: Waste outlets for toilet and lavatory through wall. Fixture shall be fabricated entirely of 14-gauge, Type 304 stainless steel and shall include a tension/compression suspension system to transmit any shock/load to the wall to which it is attached. Exterior shall be polished to a #4 satin finish except for integral toilet seat that shall have a #7 high polished finish for sanitary reasons. Blowout jet trapway shall pass a 2” ball, be fully enclosed with all welds ground and polished to a matching #4 satin finish. Interior of cabinetry shall be spray-coated with one thick coat of mastic, non-combustible, for sound deadening and to prevent condensation formation. Fixture shall be tested for strength in a manner to simulate typical usage. No deflections with loadings up to 2000 lbs. and no permanent damage with loadings up to 5,000 lbs. A certified test report is to be made available if deemed necessary to Owner’s representative. Fixture shall be furnished with mounting hardware for wall type as indicated on the Architectural Drawings.
   4. Model:
      a. Willoughby Industries Model ECW-1846-C-ON-BPH-1.6 GPF-PLM2-EB-LWE-SLOW-TWE-TW5-PCB4-TWC4C-T4A-FV-TFE-FVT-RTH-HPS-WS.
   5. Options and Trim:
      a. Each P-1 fixture shall include the following options and trim:
         1) 18-inch wide, on-floor cabinet with wall outlet waste connections, centered toilet bowl location. ECW-1846-C-ON

2) Stainless steel Ligature-resistant filler/bubbler. BPH
3) H & C Dual Temperature pneumatic metering penal lavatory valve, H & C activated by non-hold open pneumatic stainless steel pushbutton/actuators, .5 gpm flow control, stainless steel strainers, and screwdriver operated check stops. Metering adjustable from 1 second to 90 seconds. Tubing shall be FDA approved. Valve body and check stop to be of brass construction. PML2
4) Integral 1-1/2-inch FIP stainless steel elbow waste.EB
5) 1-1/2 OD stainless steel lavatory waste connection. LWE
6) 3-inch long, 2 1/2-inch OD stainless steel toilet waste extension TWE
7) Toilet waste connection with 4-inch cast iron tee, and special coupling to adapt 2-1/2-inch OD extension to 4-inch no-hub cast iron sanitary. TW5
8) Brass plug with stainless steel pin. PCB4
9) Auto Reset Toilet Overflow Preventer. T4A
10) 1.6 gallon per flush.
11) Hydraulic flush valve FV
12) Male by male through wall flushing connection. FVT
13) Recess tissue holder, ground and polished smooth to the cabinet. RTH. Install on unit so recesses can be observed from the cell door.
14) #7 polished toilet seat. HPS
15) Wall sleeve Model WS. Verify exact thickness required.
16) Starter Fittings: Fully baffled drainage fitting as manufactured by Tyler or Charlotte Pipe and Foundry.

6. Additional items:
   a. Each P-1 fixture shall include the following:
      1) Individual ball type shut off valves to each manifold distribution control box.
      2) All drainage, vent and water piping to make final connections to fixture.
      3) Refer to drawings for additional items.

B. Security Combination Units, C-1F:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Acorn Engineering Company.
   b. Metcraft Industries Inc.
   c. Willoughby Industries, Inc.
2. Description: Front-mounting, cabinet, centered toilet bowl, security plumbing fixture with integral water closet and lavatory; fabricated from 14 gauge thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
3. Combination Lav/Toilet: Waste outlets for toilet and lavatory through wall. Fixture shall be fabricated entirely of 14-gauge, Type 304 stainless steel and shall include a tension/compression suspension system to transmit any shock/load to the wall to which it is attached. Exterior shall be polished to a #4 satin finish except for integral toilet seat that shall have a #7 high polished finish for sanitary reasons. Blowout jet trapway shall pass a 2--inch ball, be fully enclosed with all welds ground and polished to a matching #4 satin finish. Interior of cabinetry shall be spray-coated with one thick coat of mastic, non-combustible, for sound deadening and to prevent condensation formation. Fixture shall be tested for strength in a manner to simulate typical usage. No deflections with loadings up to 2000 lbs. and no permanent damage with loadings up to 5,000 lbs. A certified test report is to be made available if deemed necessary to Owner’s representative. Fixture shall be furnished with mounting hardware for wall type indicated on the Architectural Drawings.
4. Model:

a. Willoughby Industries Model ECW-1846-FA-C-ON-BPH-1.6 GPF-PML2-PBH-RPT-GWC-TWC4C-T4A-FV-RTH-HPS-MT.
b. Acorn Engineering Company
c. Metcraft Industries

5. Options and Trim:
   a. Each C-1F fixture shall include the following options and trim:
      1) 18-inch wide, on-floor cabinet with wall outlet waste connections, centered toilet bowl location. ECW-1846-C-ON-FA
      2) Stainless steel ligature-resistant filler/bubbler. BPH
      3) H & C pneumatic penal lavatory valve, H & C activated by non-hold open pneumatic stainless steel pushbutton/actuators, .5 gpm flow control, stainless steel strainers, and screwdriver operated check stops. Metering adjustable from 1 second to 90 seconds. Tubing shall be FDA approved. Valve body and check stop to be of brass construction. Valve to be factory installed inside cabinet of fixture. PML-2.
      4) 1-1/2-inch rough brass lav trap with cleanout plug-accessible through access panels. Removable trap assembly. RPT.
      5) Waste coupling extension: TWC4C.
      6) Toilet overflow preventer. T4A, factory installed inside cabinet on fixture. Automatic reset.
      7) Recess tissue holder, ground and polished smooth to the cabinet. RTH.
      8) #7 polished toilet seat. HPS
      9) Wall template: MT
      10) Low consumption, 1.6 GPF hydraulic, penal, concealed, rough brass flush valve, model to suit fixture. FV. Factory installed inside cabinet of fixture.
      11) Removable front and side accessible access panels.
      12) Starter Fitting: Fully baffled fitting as manufactured by Tyler or Charlotte Pipe and Foundry.

C. Security Combination Units, C-1F-M:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Engineering Company.
      b. Metcraft Industries Inc.
      c. Willoughby Industries, Inc.
   2. Description: Front-mounting, cabinet, centered toilet bowl, security plumbing fixture with integral water closet and lavatory; fabricated from 14 gauge thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
   3. Model: Same as specified for C-1F, except without starting fitting. Fixture is for training personnel and plumbing personnel for maintenance of front access fixtures.

D. Security Combination Units, C-2F, HC:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Engineering Company
      b. Metcraft Industries
      c. Willoughby Industries, Inc.
   2. Description: Front mounting, large deck type cabinet, security plumbing fixture, ADA compliant, with integral water closet and lavatory; fabricated from 14 gauge thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.

3. Combination Lav/Toilet: Waste outlets for toilet and lavatory through wall. Fixture shall be fabricated entirely of 14-gauge, Type 304 stainless steel and shall include a tension/compression suspension system to transmit any shock/load to the wall to which it is attached. Exterior shall be polished to a #4 satin finish except for integral toilet seat that shall have a #7 high polished finish for sanitary reasons. Blowout jet trapway shall pass a 2-inch ball, be fully enclosed with all welds ground and polished to a matching #4 satin finish. Interior of cabinetry shall be spray-coated with one thick coat of mastic, non-combustible, for sound deadening and to prevent condensation formation. Fixture shall be tested for strength in a manner to simulate typical usage. No deflections with loadings up to 2000 lbs. and no permanent damage with loadings up to 5,000 pounds. A certified test report is to be made available if deemed necessary to Owner's representative. Fixture shall be furnished with mounting hardware for wall types a indicated on Architectural Drawings.
4. Model:
    a. Willoughby Industries Model ECW-3696-FA-L/R-ON-DMBH-1.6-PML2-PBH-RPT-GWC-GB4296-T4A-FV-RTH-HPS-MT.
    b. Acorn Engineering Company
    c. Metcraft Industries
5. Options and Trim:
    a. Each C-2F, HC fixture shall include the following options and trim:
        1) 36-inch wide, on-floor cabinet with wall outlet waste connections, centered toilet bowl location. ECW-3696-FA-L/R-ON
        2) Stainless steel Ligature-resistant deck mounted filler/bubbler. DMBH
        3) H & C pneumatic penal lavatory valve, H & C activated by non-hold open pneumatic stainless steel pushbutton/actuators, .5 gpm flow control, stainless steel strainers, and screwdriver operated check stops. Metering adjustable from 1 second to 2 minutes. Tubing shall be FDA approved. Valve body and check stop to be of brass construction. Valve to be factory installed inside cabinet of fixture. PML2.
        4) 1-1/2-inch rough brass lav trap with cleanout plug-accessible through access panels. Removable trap assembly.
        5) Gasketed waste connection. GWC.
        6) Toilet overflow preventer. T4A, factory installed inside cabinet on fixture. Automatic reset.
        7) 1.6 gallon per flush. FV
        8) Recess tissue holder, ground and polished smooth to the cabinet. RTH
        9) #7 polished toilet seat. HPS
        10) Wall Template: MT.
        11) Low consumption, hydraulic, penal, concealed, rough brass flush valve, model to suit fixture FV. Factory installed inside cabinet of fixture.
        12) Removable front accessible access panels.
        13) Grab bar on fixture and adjacent wall.

2.02 SECURITY WATER CLOSETS

A. Security Water Closets, P-2,HC: (Furnished as part of Pre Cast Package)
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Acorn Engineering Company.
        b. Metcraft Industries Inc.
        c. Willoughby Industries, Inc.
    2. Description: Stainless steel toilet, back supply, blowout jet type, wall hung with elongated bowl and integral toilet seat. Toilet trap shall pass 2-inch diameter ball thickness, ASTM A

666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.

3. Model:
   a. Willoughby Model: ETW-1490-OF-BS-1.6-TWE-TW5-PC4-T4A-FV-FVT-HPS-WS-RTH1
      1) Standard Equipment: Elongated toilet bowl with contoured seat and integral crevice-free, self-draining flushing rim with positive after fill.
      2) Toilet shall be blowout type. Trap shall be fully closed, maintain a minimum 3-1/2-inch seal and pass a 2-inch ball overflow preventer.
      3) Unexposed interior surfaces shall be spray coated with a sound-deadening, fire-retardant insulation.
      4) Anchoring: Standard 4-point system with threaded rod, nuts, and washers furnished for walls up to 8 inches thick.
      5) 2-1/2-inch OD toilet waste tube with plain end extended 4 inches past back of fixture for NH type connection. TWE
      6) High polished seat. HPS
      7) Security wall sleeve. WS
      8) 14 gauge recessed tissue holder (install in wall) adjacent to fixture. RTH1.
      9) Flushing connection. FVT.
      10) Overflow preventer T4A, automatic reset.
      11) Sloan or Zurn penal concealed rough brass flush valve. FV
      12) Zurn starter fitting, Model to suit application.

B. Security Water Closets, SWC-1:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Engineering Company.
      b. Metcraft Industries Inc.
      c. Willoughby Industries, Inc.
   2. Description: Stainless steel toilet, back supply, blowout jet type, wall hung with elongated bowl and integral toilet seat. Toilet trap shall pass 2 1/8-inch diameter ball thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
   3. Model:
      a. Willoughby Model: ETW-1490-OF-BS-1.6-TWE-TW5-TWC4C-T4A-FV-FVT-HPS-WS-RTH1-AP
         1) Standard Equipment: Elongated toilet bowl with contoured seat and integral crevice-free, self-draining flushing rim with positive after fill.
         2) Toilet shall be blowout type. Trap shall be fully closed, maintain a minimum 3-1/2-inch seal and pass a 2-inch ball overflow preventer.
         3) Unexposed interior surfaces shall be spray coated with a sound-deadening, fire-retardant insulation.
         4) Anchoring: Standard 4-point system with threaded rod, nuts, and washers furnished for walls up to 8 inches thick.
         5) 2-1/2-inch OD toilet waste tube with plain end extended 4 inches past back of fixture for NH type connection. TWE
         6) High polished seat. HPS
         7) Security wall sleeve. WS
         8) 14 gauge recessed tissue holder (install in wall) adjacent to fixture. RTH1.
         9) Flushing connection. FVT.
         10) Overflow preventer T4A, automatic reset.

11) Sloan or Zurn penal concealed rough brass flush valve. Access panel for flush valve, Willoughby AP.
12) Access Panel; 14 gauge minimum 21-inch by 21-inch, provided and installed by this Contractor. Located between water closet and lavatory for access to valves and making final connection to fixtures. See detail on plumbing drawings.
13) Zurn starter fitting, Model to suit application.

C. Security Water Closets, SWC-1, HC:
1. Same as specified for SWC-1, except mounted at handicapped height.

2.03 SECURITY LAVATORIES

A. Security Lavatories, P-3,HC: (Furnished as part of Pre Cast Package)
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Acorn Engineering Company.
b. Metcraft Industries Inc.
c. Willoughby Industries, Inc.
2. Description: Back-mounting security plumbing fixture; fabricated from14 gauge thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
3. Model:
a. Willoughby Industries Model HS-1013-46-HC-SBPH-PML2-PBH-EB-LWE-SLOW-LW1-WS.
1) Receptor: Oval bowl with integral soap depression and backsplash.
2) Hot- and Cold-Water Supply Valves: Pneumatic activated by non-hold open pneumatic stainless steel pushbutton/actuators, .5 gpm flow control, stainless steel strainers, and screwdriver operated check stops. Metering adjustable from 1 second to 90 seconds. Tubing shall be FDA approved. Valve body and check stop to be of brass construction. PML2.
3) Lavatory Valve Actuation: Ligature-Resistant Pneumatic Push Buttons. PBH
4) Bubbler: Security Ligature-resistant Penal Bubbler / filler SBPH.
4. Drain: Integral punched grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2.
5. Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.

B. Security Lavatories, SSL-1, HC:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Acorn Engineering Company.
b. Metcraft Industries Inc.
c. Willoughby Industries, Inc.
2. Model:
a. Willoughby Industries Model HS-1013-46-HC-SBPH-PML2-PBH-EB-LWE-LW1-WS-AP.
b. Receptor: Oval bowl with integral soap depression and backsplash.
c. Hot- and Cold-Water Supply Valves: Pneumatic activated by non-hold open pneumatic stainless steel pushbutton/actuators, .5 gpm flow control, stainless steel strainers, and screwdriver operated check stops. Metering adjustable from 1 second to 90 seconds. Tubing shall be FDA approved. Valve body and check stop to be of brass construction. PML2.
d. Lavatory Valve Actuation: Ligature-Resistant Pneumatic Push Buttons. PBH
e. Bubbler: Security Ligature-resistant Penal Bubbler / filler.SBPH.

f. Provide access panel for making final connections and maintenance to valves and trap.
g. Access Panel: 14 gauge minimum, 21-inch x 21-inch, provided and installed by this Contractor. Locate between water closet and lavatory. Where conditions and space permits, access panels shall be installed behind fixtures to allow access to chase from the rear. Secured with vandal proof screws. Panel provides access for installing water closet and lavatory and making final connections. Refer to detail on plumbing drawings.
h. Drain: Integral punched grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2.
i. Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture. WS

2.04 SHOWERS

A. Security Shower Cabinet, SSH-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Acorn Engineering Company.
b. Metcraft Industries Inc.
c. Willoughby Industries, Inc.
2. Description: Cabinet type, rear access 14-gauge thickness, one-piece, continuously welded to form a leak proof enclosure, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing. Style to match chase wall location.
3. Model:
a. Willoughby Industries, Model US-3636-L/R-PML1-PBH-1.5-NPS-ICD-VG-CP-MD-TH1-RD-ZC-TMV.
b. Configuration: Cabinet 36 by 36 inches.
c. Waste Connection: Integral perforated strainer with 2-inch OD stainless steel 2-inch chalk type drain through floor with removable perforated stainless steel strainer, secured with stainless steel vandal proof screws.
d. Shower Valve: Single temperature, pneumatic metering with brass strainer/check stop inlet. PML1
e. Push Button: Ligature-resistant Pneumatic PBH.
f. Shower head: Stainless steel, non-adjustable, 1.5 gpm flow rate, mounted in front corner panel. Pre-piped to the front left or right jamb, under the shower floor with 1/2-inch polyethylene tubing to the pipe chase. Shower head L/R orientation as indicated on the Architectural Drawings. NPS
g. RD: Recessed mounted soap dish.
h. TH1: Released towel hook.
i. MD: Modesty door with attached door bumpers.
j. VG: Ventilator grille; rated at 50 cfm at maximum .1” W.C. static pressure loss. Provide stainless steel bracket attachment for mechanical ductwork connection. Ventilator grille shall be located in location as indicated on the HVAC drawings. Coordination exact location of grille location with Mechanical Contractor prior to fabrication.
k. Shower floor shall be fabricated from 11 gauge stainless steel to prevent flexing. Floor shall have slip resistant surface.
l. Cabinet Closures: Vertical and horizontal, 14 gauge, stainless steel custom enclosures to cover all corners, seams, and extensions to ceiling. CP.
m. ZC: Z-clip floor mounting to anchor cabinet floor.

n. Thermostatic Mixing Valve: TMV meeting ANSI 1070. Temperature supported with, thermostatic mixing valve installed directly behind shower in accessible pipe chase. Mixing valve shall be provided with unions on inlet and outlet, check stops, strainer and dial thermometer and ball valve on outlet. Adjust temperature to 105 deg F set point. Valve shall be equal to Leonard Valve model 210- LF. or equal as provided my the security manufacturer. Meeting ANSI 1070. Mixing valve manufacturer shall provide written documentation that valve will operate satisfactory with a minimum incoming water temperature difference between hot and cold of 8 degrees.

B. Security Shower Cabinet, SSH-2F, HC:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Engineering Company.
      b. Metcraft Industries Inc.
      c. Willoughby Industries, Inc.
   2. Description: Cabinet type, Front-access, accessible shower cabinet, ADA compliant, transfer cabinet shower. One-piece continuously welded to form leak proof enclosure, 14 gauge thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing. Style to match chase wall. Requires 2-inch recessed in floor.
   3. Model:
      a. Willoughby Industries, Model US-3636-HC-FA-L/R-PML1-PML1-MA2-PBH-1.5-APS-2HD-ICD-VG-CP-CR-TH1-RD-TMV.
      b. Configuration: Cabinet 36 by 36 inches inside, with floor and top and with stainless-steel soap dish, towel hook, and integral stainless steel fold up seat and drain. Fold-up stainless steel shower seat, 18" 33" horizontally-mounted L-shaped grab bar, 24" vertically-mounted grab bar.
      c. Shower Valve: two pushbutton, pneumatic metering valves with brass strainer/check stop inlet.. One pushbutton shall operate the upper (standard) penal shower head and another shall operate the lower penal shower head PML1,PML1-MA2
      d. Cabinet Closure Panels: Vertical and horizontal, 14 gauge, stainless steel custom enclosure to cover all corners, seams, and extensions to ceiling. CP.
      e. Release Towel Hook. TH1.
      f. Shower head: Two required, stainless steel, 30 degree adjustable shower head with vandal resistant adjustable spray, 1.5 GPM. 2HD-APS.
      g. Recessed stainless steel integral soap dish. RD.
      h. Break-away Security curtain rod. CD Verify with Owner at shop drawing submittal.
      i. VG: Ventilator grille; rated at 50 cfm at maximum .1” W.C. static pressure loss. Provide stainless steel bracket attachment for mechanical ductwork connection. Ventilator grille shall be located where connection is indicated on the HVAC drawings. Coordinate exact location of grille with Mechanical Contractor prior to fabrication.
      j. Waste Connection: 2-inch caulk type drain with removable perforated stainless steel strainer secured with stainless steel vandal proof screws.
      k. Shower floor shall be fabricated from 11 gauge stainless steel to prevent flexing. Floor shall have slip resistant surface.
      l. Fold-up handicapped ADA stainless steel seat. FSS
      m. Thermostatic Mixing Valve: TMV meeting ANSI 1070. Temperature supported with, thermostatic mixing valve installed directly behind shower in accessible pipe chase. Mixing valve shall be provided with unions on inlet and outlet, check stops, strainer and dial thermometer and ball valve on outlet. Adjust temperature to 105 deg F set point. Valve shall be equal to Leonard Valve model 210 F. or equal as provided my the security manufacturer. Meeting ANSI 1070. Mixing valve manufacturer shall

provide written documentation that valve will operate satisfactory with a minimum incoming water temperature difference between hot and cold of 8 degrees.

2.05 ELECTRICALLY OPERATED BALL VALVE

A. For controlling gang showers from Officer Station

B. Manufacturers:
   1. Nibco. Inc
   2. Apollo, Division of Conbraco Industries, Matthews,

C. Ball Valves: MSS-110, Copper-alloy or stainless steel, lead-free. Threaded end, two-piece body, blowout-proof stem, full port, actuator ready, 150S-600 WOG rated.
   1. Apollo Series: 77AR8-64
   2. Nibco Series: TM-585-70-66

D. Electric Actuator:
   1. Apollo Series: AE-600-10, 115 VAV
   2. Nibco Series NE-100

E. Mounting Bracket
   1. Refer to valve manufacturer for selection recommendations.
   2. Apollo Series 78-1538-01

2.06 DRINKING FOUNTAINS

A. Security Drinking Fountains, SDF-2F,HC
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Engineering Company.
      b. Metcraft Industries Inc.
      c. Willoughby Industries.
   2. Description: Front-mounting, split-level, dual height, ADA accessible security plumbing fixture; fabricated from 14 gauge, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      a. Receptor: Bowl or depression in top and with backsplash.
      b. Bubbler Location: On deck.
      c. Bubbler Water-Supply Valve: (2) Pneumatic type with push-button actuation.
      d. Drain: Integral punched grid with NPS 1-1/4 minimum tailpiece, trap, and waste, and complying with ASME A112.18.2.
      e. Access to Internal Components: Vandal-resistant access panels, located under unit.
      f. Mounting Device: Wall bracket.
   3. Model:
      a. Willoughby Industries Equal to Model WDF-2-4219, drawing P173019A, dated 7/26/27 or equal.
      b. Acorn Model
      c. Metcraft Model

2.07 SECURITY DETOX TOILETS

A. Security Detox Toilet DT-1
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Engineering Company.
      b. Metcraft Industries Inc.
      c. Willoughby Industries.

2. Description: Designed for in-the-floor installation. Fabricated of 14 gauge, Type 304 stainless steel, seamlessly welded to form a one-piece, vandal resistant toilet. Blowout type trap, 14-inch diameter round bowl, 2-inch top band, removable 7 gauge stainless steel top grate for access to bowl interior, and integral crevice free flushing rim with positive after fill. Verify flange requirement with actual floor finish.
    a. Remote Flush Valve: FV-1 Flush valve, flush valve with stainless steel recessed access box for remote installation. Flush valve shall be Zurn or Sloan, Model to suit.
    b. Hose box: Provide Stainless steel, recessed box, hot & cold water supplies with vandal proof cover, vacuum breaker.
3. Model:
    a. Willoughby Industries: FD-1400-WF-1.6-FV-REFVB
    b. Acorn Model.
    c. Metcraft

2.08 FIXTURE SUPPORT

A. Support all security fixtures with manufacturer's security wall sleeve and installation details. For areas where security wall sleeve cannot be installed, install following:

B. Off-Floor, Plumbing Fixture Supports:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Josam Company.
    b. Smith, Jay R. Mfg. Co.
    c. Tyler Pipe; Wade Div.
    d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Description: ASME A112.6.1M carriers with dimensions and trim matching fixture.
    a. Stainless-Steel, Front-Mounting Fixtures: With modifications.
        1) Drinking Fountains: Type I drinking fountain carrier.
        2) Lavatories: Type III lavatory carrier.
        3) Urinals: Type I urinal carrier with inlet seal unless Type II is required.
        4) Water Closets: Combination support and waste fitting assembly.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before security plumbing fixture installation.

B. Examine floors and walls for suitable conditions where security plumbing fixtures will be installed.

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

3.02 SECURITY PLUMBING FIXTURE INSTALLATION

A. Install back-mounting-type, stainless-steel security plumbing fixtures as follows:
1. Install wall sleeve in wall.
2. Install fixture on wall sleeve; mount components on or attached to wall sleeve with access from accessible service space.
3. Extend supply piping from service space to fixture.
4. Install soil and waste piping from fixture and extend into service space.
5. Install fixture trap in service space instead of below fixture drain.
6. Install ball valve, accessible from access panel, on hot and cold supplies to fixtures.

B. Install front-mounting-type, stainless-steel security plumbing fixtures as follows:
1. Install fixture support or mounting bracket.
2. Install fixture on support; mount components inside of or attached to fixture.

3. Extend supply piping from pipe space to fixture.
4. Install trap below fixture and extend soil and waste piping into pipe space.
5. Install ball valve on branch hot and cold supplies to fixtures.

C. Install security plumbing fixture outlets with gasket seals and connectors.

D. Install fixtures designated "accessible" according to ICC A117.1 for heights, dimensions, and clearances.

E. Install fixtures level and plumb.

F. Install shutoff valves in water-supply piping to fixtures. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "Plumbing Piping". Each security fixture shall be individually controlled by use of ball valve.

G. Install dielectric fittings in water-supply piping to fixtures if piping and fixture connections are made of different metals. See Division 22 Section "Common Work Results for Plumbing" for dielectric fittings.

H. Adjust outlet temperature on all shower temperature control valves. Remove strainer, clean and replace, after all water mains have been disinfected and flushed. Verify outlet temperature is as scheduled on the drawings.

3.03 ELECTRICALLY OPERATED VALVES

A. Water supplies to all the gang showers shall be controlled with an electrically operated ball valve controlled from the Officer Station console. Refer to drawings for location.

B. Valves while assembled to the actuator shall be screwed to the supply pipe.

C. Plumbing Contractor shall provide three leads and ground from valve to a SPDT switch located in control console. Conduit from valve to control console shall be by the Electrical Contractor. A 120-volt circuit and on/off switch will be provided and connected by the Electrical Contractor at the valve location

D. Install valve and actuators per manufacturer's recommendations. Coordinate location of switch with Detention Equipment Supplier for incorporating into the control console.

E. All valves and actuators with mounting hardware shall be assemble and tested by factory-authorized center or at the factory.

F. Inform Owner to operate actuators at least once a month.

3.04 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot- and cold-water supply piping to security plumbing fixtures. Include ball valve on each supply. Ball valves are specified in Division 22 "Plumbing Piping"

C. Connect soil and waste piping to security plumbing fixtures.

3.05 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
1. Testing: After installing security plumbing fixtures test for compliance with requirements.
2. Remove and replace malfunctioning security plumbing fixtures. Retest as specified above after repairs or replacements are made.

3.06 ADJUSTING

A. Operate and adjust water-supply flushometers and flow-control valves on security plumbing fixtures.

B. Adjust flow for lavatories at 15 seconds.

C. Adjust flow at showers for 60 seconds.

D. Adjust bubbler so water flow is in center of lavatory bowl.

3.07 CLEANING

A. Clean security plumbing 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 spouts and strainers.
   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.

3.08 PROTECTION

A. Provide protective covering for installed security plumbing fixtures and fittings.

B. Do not allow use of security plumbing fixtures for temporary facilities unless approved in writing by Owner.

3.09 SEALANT

A. Seal all fixtures to wall and floor surfaces with sealant as specified in Division 07 Section "Joint Sealants" to match fixtures.

3.10 SECURITY FIXTURES INSTALL BY PRECAST CELL MANUFACTURER

A. Plumbing Contractor shall make final connections to all security fixtures installed by the precast cell contactor. Final connections shall include all water, waste, vent systems for total operation of the security fixture.

B. Flush all water lines prior to connecting to cell fixtures.

C. This contractor shall take full responsibility for the full operation of all fixtures installed by the Pre Cast Cell Contractor.

D. Refer to drawings for additional requirements.

END OF SECTION 224600

SECTION 23 0513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

1.03 REFERENCE STANDARDS

A. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.

B. NEMA MG 1 - Motors and Generators.

C. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

1.05 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

C. Source Limitations: The practice of name branding by one manufacturer of another manufacturers product is not allowed.

D. The motor manufacturer shall be a member in good standing with the National Electrical Manufacturers Association (NEMA).

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which the manufacturer agrees to repair or replace motors that fail in materials or workmanship within the specified warranty period.

1. Warranty Period: Three years from date of substantial completion

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Baldor Electric Company/ABB Group.

B. Leeson Electric Corporation.

C. Regal-Beloit Corporation (Century).

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment equipment schedules or Sections.

B. Electrical Service:
   1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
   2. Motors Larger than 1/2 Horsepower: 208 or 480 volts, three phase, 60 Hz.

C. Construction:
   1. Open drip-proof type except where specifically noted otherwise.
   2. Design for continuous operation in 104 degrees F environment.
   3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

E. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.05 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.06 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.07 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

G. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

H. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

2.08 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Applications:
   1. Commercial:
      a. Power Roof Ventilator (PRV):
         1) Operating Mode: Constant cfm.
         2) Input: Motor manufacturer to coordinate control requirements with the control board of the PRV and/or specified sequence of operation.
         3) Shaft Extension: Single.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION

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SECTION 23 0517
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Pipe sleeves.

B. Manufactured sleeve-seal systems.

1.03 RELATED REQUIREMENTS

A. Section 23 0523 - General-Duty Valves for HVAC Piping.

B. Section 23 0553 - Identification for HVAC Piping and Equipment: Piping identification.

C. Section 23 0719 - HVAC Piping Insulation.

1.04 REFERENCE STANDARDS

A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.

1.05 SUBMITTALS

A. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.06 QUALITY ASSURANCE

A. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.

B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

1.08 WARRANTY

A. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

A. Manufacturers:
   1. Flexicraft Industries; Pipe Wall Sleeve.

B. Vertical Piping:
   1. Sleeve Length: 2 inch above finished floor.
   2. Provide sealant for watertight joint.
   3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
   4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

C. Plastic or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.

D. Pipe Passing Through Below Grade Exterior Walls:
   1. Zinc coated or cast iron pipe.

2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.

E. Clearances:
1. Provide allowance for insulated piping.
2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
3. All Rated Openings: Caulked tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.02 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Manufacturers:
1. Advance Products & Systems, LLC; Innerlynx.
2. Flexicraft Industries; PipeSeal.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

B. Install piping to conserve building space, to not interfere with use of space and other work.

C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

D. Inserts:
1. Provide inserts for placement in concrete formwork.

E. Structural Considerations:
1. Do not penetrate building structural members unless indicated.

F. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
2. Aboveground Piping:
a. Pack solid using mineral fiber in compliance with ASTM C592.
b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
3. All Rated Openings: Caulk tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.
4. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.

G. Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a water-tight seal.

6. Install in accordance with manufacturer's recommendations.

H. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 CLEANING

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

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SECTION 23 0519
METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Pressure gauges and pressure gauge taps.

B. Thermometers and thermometer wells.

C. Static pressure gauges.

D. Filter gauges.

1.03 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments.

B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers.

C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.

1.04 SUBMITTALS

A. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

1.05 FIELD CONDITIONS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

A. Manufacturers:
   1. Dwyer Instruments, Inc
   2. Moeller Instrument Company, Inc
   3. Omega Engineering, Inc

B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
   1. Case: Steel with brass bourdon tube.
   2. Size: 4-1/2 inch diameter.
   3. Mid-Scale Accuracy: One percent.
   4. Scale: Psi.

2.02 PRESSURE GAUGE TAPPINGS

A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.

B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.

C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

2.03 STEM TYPE THERMOMETERS

A. Manufacturers:
   1. Dwyer Instruments, Inc

2. Omega Engineering, Inc
3. Weksler Glass Thermometer Corp

B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
1. Size: 9 inch scale.
2. Window: Clear Lexan.
3. Stem: 3/4 inch NPT brass.
4. Accuracy: 2 percent, per ASTM E77.
5. Calibration: Degrees F.

2.04 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

2.05 TEST PLUGS

A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Viton core for temperatures up to 400 degrees F.

2.06 STATIC PRESSURE GAUGES

A. Manufacturers:
1. Dwyer Instruments, Inc
2. Omega Engineering, Inc
3. Veris Industries
4. Weksler Glass Thermometer Corp

B. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.

C. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.

D. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

C. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Extend nipples to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

E. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.

F. Coil and conceal excess capillary on remote element instruments.

G. Provide instruments with scale ranges selected according to service with largest appropriate scale.

H. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

I. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

J. Locate test plugs adjacent to pressure gages and pressure gage taps.

END OF SECTION

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SECTION 23 0523
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Applications.

B. General requirements.

C. Ball valves.

D. Butterfly valves.

E. Check valves.

1.03 RELATED REQUIREMENTS

A. Section 23 0553 - Identification for HVAC Piping and Equipment.

B. Section 23 0719 - HVAC Piping Insulation.

C. Section 23 2113 - Hydronic Piping.

1.04 ABBREVIATIONS AND ACRONYMS

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. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. SWP: Steam working pressure.

I. TFE: Tetrafluoroethylene.

1.05 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

C. ASME B31.9 - Building Services Piping.

D. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fuzing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications.

E. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

F. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

G. MSS SP-68 - High Pressure Butterfly Valves with Offset Design.

H. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.

I. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service.

J. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.

K. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.06 SUBMITTALS

A. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

B. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.07 QUALITY ASSURANCE

A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.

B. Welding Materials and Procedures: Conform to ASME BPVC-IX.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
   2. Protect valve parts exposed to piped medium against rust and corrosion.
   3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
   4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
   5. Secure check valves in either the closed position or open position.
   6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors in dry environment.

C. Exercise the following precautions for handling:
   1. Handle large valves with sling, modified to avoid damage to exposed parts.
   2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. Provide the following valves for the applications if not indicated on Drawings:
   1. Throttling (Hydronic): Ball.
   2. Isolation (Shutoff): Ball.
   3. Swing Check (Pump Outlet):
      a. 2 NPS and Smaller: Bronze with bronze disc.
      b. 2-1/2 NPS and Larger: Iron with lever and weight.

B. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.

C. Required Valve End Connections for Non-Wafer Types:
   1. Copper Tube:
      a. 2 NPS and Smaller: Threaded ends (Exception: Solder-joint valve-ends).
      b. 2-1/2 NPS and Larger: Grooved ends.

D. Heating Hot Water Valves:
   1. 2 NPS and Smaller, Brass and Bronze Valves:
      a. Threaded ends.
      b. Ball: Full port, one piece, brass trim.

c. Swing Check: Bronze disc, Class 125.

2. 2-1/2 NPS and Larger, Iron Valves:
   a. Ball: 2-1/2 NPS to 10 NPS, Class 150.
   b. Butterfly: High performance, single flange, Class 150.
   c. Swing Check: 2-1/2 NPS to 12 NPS, lever and spring closure control, Class 125.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
   1. Hand Lever: Quarter-turn valves 6 NPS and smaller.

D. Valves in Insulated Piping: Provide 2 NPS stem extensions and the following features:
   1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   2. Memory Stops: Fully adjustable after insulation is installed.

E. Valve-End Connections:
   1. Threaded End Valves: ASME B1.20.1.
   2. Solder Joint Connections: ASME B16.18.

F. General ASME Compliance:
   1. Building Services Piping Valves: ASME B31.9.

2.03 BRASS BALL VALVES

A. Three Piece, Full Port with Stainless Steel Trim:
   1. Comply with MSS SP-110.
   2. SWP Rating: 150 psig.
   3. CWP Rating: 600 psig.
   4. Body: Forged brass.
   5. Ends: Threaded.
   6. Seats: PTFE.
   7. Stem: Stainless steel.
   8. Ball: Stainless steel, vented.

2.04 BRONZE BALL VALVES

A. Three Piece, Full Port with Stainless Steel Trim:
   1. Comply with MSS SP-110.
   2. SWP Rating: 150 psig.
   3. CWP Rating: 600 psig.
   4. Body: Bronze.
   5. Ends: Threaded.
   6. Seats: PTFE.
   7. Stem: Stainless steel.
   8. Ball: Stainless steel, vented.

2.05 IRON BALL VALVES

A. Split Body, Full Port:
   1. Comply with MSS SP-72.
   2. CWP Rating: 200 psig.
   3. Body: ASTM A126, gray iron.

4. Ends: Flanged.
5. Seats: PTFE.
6. Stem: Stainless steel.
7. Ball: Stainless steel.

2.06 HIGH-PERFORMANCE SINGLE FLANGE BUTTERFLY VALVES

A. Lug type: Bi-directional dead end service without downstream flange.
1. Comply with MSS SP-68.
2. Class 150: CWP Rating: 285 psig at 100 degrees F.
3. Body: Provide cast iron or ductile Iron.
4. Seat: Metal or reinforced PTFE.
5. Offset stem: Stainless steel.
6. Disc: Carbon steel.

2.07 BRONZE SWING CHECK VALVES

A. Class 125: CWP Rating: 200 psig (1380 kPa).
1. Comply with MSS SP-80, Type 3.
2. Body Design: Horizontal flow.
3. Body Material: Bronze, ASTM B62.
4. Ends: Threaded.
5. Disc: Bronze.

2.08 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125:
1. Comply with MSS SP-71, Type I.
2. 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
3. Body Design: Clear or full waterway.
4. Body Material: ASTM A126, gray iron with bolted bonnet.
5. Ends: Flanged.
6. Trim: Bronze.
7. Gasket: Asbestos free.
8. Closer Control: Factory installed, exterior lever, and spring or weight.

PART 3 EXECUTION

3.01 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. Should valve is determined to be defective, replace with new valve.

3.02 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

D. Install check valves where necessary to maintain direction of flow as follows:

1. Lift Check: Install with stem plumb and vertical.
2. Swing Check: Install horizontal maintaining hinge pin level.

END OF SECTION

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SECTION 23 0529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Support and attachment components for equipment, piping, and other HVAC/hydronic work.

1.03 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.

1.04 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping.

D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.

E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.

F. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

H. MFMA-4 - Metal Framing Standards Publication.

I. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

1.07 QUALITY ASSURANCE

A. Comply with applicable building code.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
   5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
      b. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      c. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   1. Manufacturers:
      a. Cooper B-Line, a division of Eaton Corporation
      b. Ferguson Enterprises Inc
      c. Thomas & Betts Corporation
      d. Unistrut, a brand of Atkore International Inc
   2. Provide factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   3. Comply with MFMA-4.
   4. Channel Material:
      a. Indoor Dry Locations: Use zinc-plated steel.
   5. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
   6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.

C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
   1. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports: 1/2 inch diameter.
      b. Piping up to 1 inch (27 mm) nominal: 1/4 inch diameter.
      c. Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter.

D. Pipe Supports:
   1. Liquid Temperatures Up To 122 degrees F:
      a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
   2. Operating Temperatures from 122 to 446 degrees F:

a. Overhead Support: MSS SP-58 Type 1 or 3 through 12, with appropriate saddle of MSS SP-58 Type 40 for insulated pipe.

E. Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.
1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

F. Strut Clamps: Two-piece pipe clamp.

G. Pipe Hangers: For a given pipe run, use hangers of the same type and material.
1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
2. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.

H. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

I. Pipe Shields for Insulated Piping:
1. Manufacturers:
a. Anvil International
2. General Construction and Requirements:
a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
b. Shields Material: UV-resistant polypropylene with glass fill.
c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
d. Minimum Service Temperature: Minus 40 degrees F.
e. Maximum Service Temperature: 178 degrees F.
f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

J. Anchors and Fasteners:
1. Manufacturers - Mechanical Anchors:
a. Hilti, Inc
b. ITW Red Head, a division of Illinois Tool Works, Inc
c. Powers Fasteners, Inc
d. Simpson Strong-Tie Company Inc
2. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
3. Steel: Use beam clamps, machine bolts, or welded threaded studs.

K. Pipe Installation Accessories:
1. Copper Pipe Supports:
a. Manufacturers:
1) HoldRite, a brand of Reliance Worldwide Corporation

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

F. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

G. Secure fasteners according to manufacturer's recommended torque settings.

H. Remove temporary supports.

END OF SECTION

SECTION 23 0548
VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Vibration isolation requirements.

B. Vibration-isolated equipment support bases.

C. Vibration isolators.

D. Vibration-isolated and/or seismically engineered roof curbs.

1.03 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

1.04 REFERENCE STANDARDS

A. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
   1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification method for spring element load capacities.

B. Shop Drawings - Vibration Isolation Systems:
   1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.

1.07 QUALITY ASSURANCE

A. Comply with applicable building code.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION REQUIREMENTS

A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing HVAC equipment and/or HVAC connections to vibration-isolated equipment.

B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:

C. General Requirements:
   1. Select vibration isolators to provide required static deflection.
   2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
   3. Select vibration-isolated equipment support bases and associated vibration isolators to provide minimum 2 inch operating clearance beneath base unless otherwise indicated.

D. Equipment Isolation: As indicated on drawings.

E. Piping Isolation:
   1. Provide vibration isolators for piping supports:
      a. Located in equipment rooms.
      b. Located within 50 feet of connected vibration-isolated equipment and pressure-regulating valve (PRV) stations.

2.02 VIBRATION ISOLATORS

A. Manufacturers:
   1. Vibration Isolators:
      a. Kinetics Noise Control, Inc.
      b. Mason Industries.
      c. Vibration Eliminator Company, Inc.

B. General Requirements:
   1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.
   2. Spring Elements for Spring Isolators:
      a. Color code or otherwise identify springs to indicate load capacity.
      b. Lateral Stability: Minimum lateral stiffness to vertical stiffness ratio of 0.8.
      c. Designed to operate in the linear portion of their load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
      d. Designed to provide additional travel to solid of not less than 50 percent of rated deflection at rated load.
      e. Selected to provide designed deflection of not less than 75 percent of specified deflection.
      f. Selected to function without undue stress or overloading.

C. Vibration Isolators for Non-Seismic Applications:
   1. Combination Resilient Material/Spring Isolator Hangers, Non-Seismic:
      a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) for the lower hanger rod connection and elastomeric (e.g. neoprene, rubber) or fiberglass isolator material for the upper hanger rod connection.
      b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short circuiting of isolation.

2.03 VIBRATION-ISOLATED AND/OR SEISMICALLY ENGINEERED ROOF CURBS

A. Manufacturers:

1. Vibration-Isolated and/or Seismically Engineered Roof Curbs:
    a. Kinetics Noise Control, Inc
    b. Mason Industries
    c. Vibration Eliminator Company, Inc

B. Vibration Isolation Curbs:
1. Non-Seismic Curb:

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

C. Secure fasteners according to manufacturer's recommended torque settings.

D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.

E. Vibration Isolation Systems:
1. Clean debris from beneath vibration-isolated equipment that could cause short circuiting of isolation.
2. Use elastomeric grommets for attachments where required to prevent short circuiting of isolation.
3. Adjust isolators to be free of isolation short circuits during normal operation.
4. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.

3.03 FIELD QUALITY CONTROL

A. Inspect vibration isolation and/or seismic control components for damage and defects.

B. Vibration Isolation Systems:
1. Verify isolator static deflections.
2. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.

C. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.

END OF SECTION

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SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe markers.

D. Ceiling tacks.

1.03 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.04 SUBMITTALS

A. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

B. Product Data: Provide manufacturers catalog literature for each product required.

C. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

A. Air Handling Units: Nameplates.

B. Air Terminal Units: Nameplates.

C. Automatic Controls: Tags. Key to control schematic.

D. Boilers: Nameplates.

E. Control Panels: Nameplates.

F. Instrumentation: Tags.

G. Major Control Components: Nameplates.

H. Piping: Pipe markers.

I. Pumps: Nameplates.

J. Small-sized Equipment: Tags.

K. Valves: Tags and ceiling tacks where located above lay-in ceiling.

L. Water Treatment Devices: Nameplates.

2.02 NAMEPLATES

A. Manufacturers:
   1. Advanced Graphic Engraving, LLC
   2. Brimar Industries, Inc
   3. Craftmark Pipe Markers
   4. Kolbi Pipe Marker Co
   5. Seton Identification Products, a Tricor Direct Company

B. Letter Color: White.

C. Letter Height: 1/4 inch.

D. Background Color: Black.

E. Plastic: Conform to ASTM D709.

2.03 TAGS

A. Manufacturers:
1. Advanced Graphic Engraving
2. Brady Corporation
3. Brimar Industries, Inc
4. Craftmark Pipe Markers
5. Kolbi Pipe Marker Co
6. Seton Identification Products, a Tricor Company

B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 PIPE MARKERS

A. Manufacturers:
1. Brady Corporation
2. Brimar Industries, Inc
3. Craftmark Pipe Markers
4. Kolbi Pipe Marker Co
5. MIFAB, Inc
6. Seton Identification Products, a Tricor Company

B. Color: Conform to ASME A13.1.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

2.05 CEILING TACKS

A. Manufacturers:
1. Craftmark

B. Description: Steel with 3/4 inch diameter color coded head.

C. Color code as follows:
1. HVAC Equipment: Yellow.
2. Fire Dampers and Smoke Dampers: Red.
3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

D. Use tags on piping 3/4 inch diameter and smaller.

1. Identify service, flow direction, and pressure.
2. Install in clear view and align with axis of piping.
3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

E. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

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SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

B. Testing, adjustment, and balancing of hydronic and refrigerating systems.

C. Measurement of final operating condition of HVAC systems.

1.03 REFERENCE STANDARDS

A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition.

B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.

C. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing.

1.04 SUBMITTALS

A. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.

B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   1. Submit to Architect.
   2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
   3. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
   4. Include at least the following in the plan:
      a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
      c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
      d. Final test report forms to be used.
      e. Procedures for formal deficiency reports, including scope, frequency and distribution.

C. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Submit to the the HVAC controls contractor within two weeks after completion of testing, adjusting, and balancing.
   2. Revise TAB plan to reflect actual procedures and submit as part of final report.
   3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
   4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
   5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.

6. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
   1. AABC (NSTSB), AABC National Standards for Total System Balance.
   2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
   3. SMACNA (TAB).

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

D. TAB Agency Qualifications:
   1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
   2. Certified by one of the following:
      a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
      b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
      c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.

E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. Fans are rotating correctly.
   7. Fire and volume dampers are in place and open.
   8. Air coil fins are cleaned and combed.
   9. Access doors are closed and duct end caps are in place.
   10. Air outlets are installed and connected.
   11. Duct system leakage is minimized.
   12. Hydronic systems are flushed, filled, and vented.
   13. Pumps are rotating correctly.
   14. Proper strainer baskets are clean and in place.
   15. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

3.04 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:
   1. Running log of events and issues.
   2. Discrepancies, deficient or uncompleted work by others.
   3. Contract interpretation requests.
   4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

3.06 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

G. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

H. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

I. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

J. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

K. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.07 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

3.08 SCOPE

A. Test, adjust, and balance the following:
   1. HVAC Pumps.
   2. Boilers.
   3. Air Cooled Refrigerant Condensers.
   4. Packaged Roof Top Heating/Cooling Units.
   5. Computer Room Air Conditioning Units.
   6. Makeup Air Units
   7. Fans.
   8. Air Terminal Units.
   9. Air Inlets and Outlets.

3.09 MINIMUM DATA TO BE REPORTED

A. Electric Motors:
   1. Manufacturer.
   2. Model/Frame.
   3. HP/BHP.
   4. Phase, voltage, amperage; nameplate, actual, no load.
   5. RPM.
   6. Service factor.
   7. Starter size, rating, heater elements.
   8. Sheave Make/Size/Bore.

B. Pumps:
   1. Identification/number.
   2. Manufacturer.
   3. Size/model.
   4. Impeller.
   5. Service.

6. Design flow rate, pressure drop, BHP.
7. Actual flow rate, pressure drop, BHP.
8. Discharge pressure.
9. Suction pressure.
10. Total operating head pressure.
11. Shut off, discharge and suction pressures.
12. Shut off, total head pressure.

C. Combustion Equipment:
1. Boiler manufacturer.
2. Model number.
3. Serial number.
4. Firing rate.

D. Air Cooled Condensers:
1. Identification/number.
2. Location.
3. Manufacturer.
4. Model number.
5. Serial number.
6. Entering DB air temperature, design and actual.
7. Leaving DB air temperature, design and actual.
8. Number of compressors.

E. Heating Coils:
1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Water flow, design and actual.
7. Water pressure drop, design and actual.
8. Entering water temperature, design and actual.
9. Leaving water temperature, design and actual.
10. Entering air temperature, design and actual.
11. Leaving air temperature, design and actual.
12. Air pressure drop, design and actual.

F. Air Moving Equipment:
1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Arrangement/Class/Discharge.
6. Air flow, specified and actual.
7. Return air flow, specified and actual.
8. Outside air flow, specified and actual.
9. Total static pressure (total external), specified and actual.
10. Inlet pressure.
11. Discharge pressure.
12. Sheave Make/Size/Bore.
13. Number of Belts/Make/Size.
14. Fan RPM.

G. Return Air/Outside Air:
   1. Identification/location.
   2. Design air flow.
   3. Actual air flow.
   4. Design return air flow.
   5. Actual return air flow.
   6. Design outside air flow.
   7. Actual outside air flow.

H. Exhaust Fans:
   1. Location.
   2. Manufacturer.
   3. Model number.
   4. Serial number.
   5. Air flow, specified and actual.
   6. Total static pressure (total external), specified and actual.
   7. Inlet pressure.

I. Duct Traverses:
   1. System zone/branch.
   2. Duct size.
   3. Area.
   4. Design velocity.
   5. Design air flow.
   6. Test velocity.
   7. Test air flow.
   8. Duct static pressure.

J. Terminal Unit Data:
   1. Manufacturer.
   2. Type, constant, variable, single, dual duct.
   3. Identification/number.
   4. Location.
   5. Model number.
   6. Size.
   7. Minimum static pressure.
   8. Minimum design air flow.
   9. Maximum design air flow.
   10. Maximum actual air flow.
   11. Inlet static pressure.

K. Air Distribution Tests:
   1. Air terminal number.
   2. Room number/location.
   3. Terminal type.
   4. Terminal size.
   5. Area factor.
   6. Design air flow.
   7. Test (final) air flow.
   8. Percent of design air flow.

END OF SECTION

SECTION 23 0713
DUCT INSULATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Duct insulation.

B. Duct liner.

1.03 RELATED REQUIREMENTS

A. Section 23 0553 - Identification for HVAC Piping and Equipment.

1.04 REFERENCE STANDARDS

A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

B. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

C. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

D. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

E. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation.

F. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

H. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

I. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.05 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

B. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of experienceand approved by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.08 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

A. Manufacturer:
   1. Johns Manville
   2. JP Lamborn Co
   3. Knauf Insulation
   4. Owens Corning Corporation
   5. CertainTeed Corporation

B. Insulation: ASTM C553; flexible, noncombustible blanket.
   1. 'K' value: 0.25 at 75 degrees F, when tested in accordance with ASTM C518.
   2. Maximum Service Temperature: 250 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent by weight.

C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Outdoor Vapor Barrier Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

F. Tie Wire: Annealed steel, 16 gage, 0.0508 inch diameter.

2.03 GLASS FIBER, RIGID

A. Manufacturer:
   1. Johns Manville
   2. Knauf Insulation
   3. Owens Corning Corporation
   4. CertainTeed Corporation

B. Insulation: ASTM C612; rigid, noncombustible blanket.
   1. 'K' Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
   2. Maximum Service Temperature: 450 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent.
   4. Minimum Density: 6.0 lb/cu ft.

C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Indoor Vapor Barrier Finish:
   1. Cloth: Untreated; 9 oz/sq yd weight, glass fabric.
   2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 FIRE BARRIER DUCTRWRAP

A. Manufacturers:
   1. 3M

B. Insulation: ASTM E2336; flexible, fire-resistant blanket.
   1. 'K' Value: 0.48 at 500 degrees F, when tested in accordance with ASTM C518.
   2. Maximum Service Temperature: [____] degrees F.
   3. Minimum Density: 6.0 lb/cu ft.

C. Tape:
   1. High performance filament tape, 3M No. 898 1 inch (25mm) wide.
   2. FSK Facing Tape with aluminum foil, fiberglass scrim, kraft paper backing: nominal 4 inches (102mm) wide (for sealing cut blanket edges and seams), 3M No. 3320.

D. Banding Material: Stainless or carbon steel banding: 1/2 inch (13mm) wide X 0.015 inch (0.4mm) thick, as stated in duct wrap Design Listing.

E. Insulation pins and clips:
   1. Copper-coated steel pins, 12 gauge with a minimum length of 4 inches (102mm) with square galvanized steel speed clips: 2.5 inch (64mm). .
   2. 12 gauge insulated cup head steel pins.

F. Through-penetration firestop materials:
   1. Packing materials: Pieces of 3M Fire Barrier Duct Wrap, or 4 pcf mineral wool.
      a. Sealants: 3M Fire Barrier: 1000 NS non-slump silicone sealant, 1003 SL self-leveling silicone sealant, 2000+ premium non-slump silicone sealant, or CP 25WB+ premium intumescent latex caulk, as stated in firestop Design Listing.

2.05 DUCT LINER

A. Manufacturers:
   1. Armacell LLC
   2. Ductmate Industries, Inc, a DMI Company
   3. Johns Manville
   4. Knauf Insulation
   5. Owens Corning Corporation
   6. CertainTeed Corporation

B. Liner type - Elastomeric Foam

C. Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 180 degrees F.
   3. Fungal Resistance: No growth when tested according to ASTM G21.
   4. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F.
   5. Minimum Noise Reduction Coefficients:
      a. 1 inch Thickness: 0.40.
   6. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm per ASTM C1071.
   7. Connection: Waterproof vapor barrier adhesive.

D. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Insulated ducts conveying air below ambient temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   3. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ducts conveying air above ambient temperature:
   1. Provide with or without standard vapor barrier jacket.
   2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.

3.03 SCHEDULES

A. Exhaust Ducts Within 10 ft of Exterior Openings:
   1. 2" Thick, Flexible or Rigid Glass Fiber Insulation

B. Outside Air Intake Ducts:
   1. 2" Thick, Flexible or Rigid Glass Fiber Insulation

C. Kitchen Exhaust Ducts:
   1. 2 Layers, 1-1/2" Thick Fire Barrier Duct Wrap

D. Plenums:
   1. 2" Thick, Flexible or Rigid Glass Fiber Insulation

E. Plenums (Cooling System):
   1. 2" Thick, Flexible or Rigid Glass Fiber Insulation

F. Supply and Return Ducts:
   1. 2" Thick, Flexible or Rigid Glass Fiber Insulation
   2. 1" Duct Liner within 15 feet of fan discharge

END OF SECTION

SECTION 23 0719
HVAC PIPING INSULATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.03 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

1.04 REFERENCE STANDARDS

A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

D. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.

E. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

F. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

G. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.

H. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

J. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.05 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.08 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, RIGID

A. Manufacturers:
   1. CertainTeed Corporation
   2. Johns Manville Corporation
   3. Knauf Insulation
   4. Owens Corning Corporation
   5. Owens Corning Corporation

B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
   1. K Value: ASTM C177, 0.23 at 75 degrees F.
   2. Maximum Service Temperature: 220 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

E. Vapor Barrier Lap Adhesive: Compatible with insulation.

F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

G. Fibrous Glass Fabric:
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Blanket: 1.0 lb/cu ft density.
   3. Weave: 5 by 5.

H. Indoor Vapor Barrier Finish:
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Vinyl emulsion type acrylic, compatible with insulation, black color.

I. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

J. Insulating Cement: ASTM C449.

2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
   1. Aeroflex USA, Inc
   2. Armacell LLC
   3. K-Flex USA LLC

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 180 degrees F.
   3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
   1. Manufacturers:
      a. Aeroflex USA, Inc

2.04 JACKETS

A. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
   1. Thickness: 0.016 inch sheet.
   2. Finish: Embossed.
   3. Joining: Longitudinal slip joints and 2 inch laps.
   4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Exposed Piping: Locate insulation and cover seams in least visible locations.

C. Insulated pipes conveying fluids below ambient temperature; insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

D. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

E. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

F. Glass fiber insulated pipes conveying fluids above ambient temperature.
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

G. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert location: Between support shield and piping and under the finish jacket.
   4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

H. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.

I. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.

J. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.03 SCHEDULE

A. Heating Systems:
   1. Heating Water Supply and Return:
      a. Piping less than 1-1/2": Rigid Glass Fiber Insulation, 1.5" Thick
      b. Piping 1-1/2" and greater: Rigid Glass Fiber Insulation, 2.0" Thick

B. Cooling Systems:
   1. Condensate Drains from Cooling Coils:
      a. All piping: Rigid Glass Fiber Insulation, 1.0" Thick
   2. Refrigerant Hot Gas and Suction:
      a. All piping: Flexible Elastomeric Insulation, 1.0' Thick

END OF SECTION

SECTION 23 0800
COMMISSIONING OF HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A.

1.02 SUMMARY

A. See Division 01 Commissioning Requirements for overall objectives.

B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.

C. The Commissioning Authority (CA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.

D. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
   1. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.03 REFERENCE STANDARDS

A. ASHRAE Guideline 1.1 - The HVAC&R Technical Requirements for the Commissioning Process.

1.04 SUBMITTALS

A. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.

B. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.

C. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
   1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
   2. Full as-built set of control drawings.
   3. Full as-built sequence of operations for each piece of equipment.
   4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
      a. Floor.
      b. Room number.
      c. Room name.
      d. Air handler unit ID.
      e. Reference drawing number.
      f. Air terminal unit tag ID.
      g. Heating and/or cooling valve tag ID.
      h. Minimum air flow rate.

i. Maximum air flow rate.

5. Full print out of all schedules and set points after testing and acceptance of the system.
6. Full as-built print out of software program.
7. Electronic copy on disk of the entire program for this facility.
8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
10. Control equipment component submittals, parts lists, etc.
11. Warranty requirements.
12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
    a. Sequences of operation.
    b. Control drawings.
    c. Points lists.
    d. Controller and/or module data.
    e. Thermostats and timers.
    f. Sensors and DP switches.
    g. Valves and valve actuators.
    h. Dampers and damper actuators.
    i. Program setups (software program printouts).

D. Project Record Documents: See Section 01 7700 for additional requirements.
1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.

E. Draft Training Plan: In addition to requirements specified in Section 01 7900, include:
1. Follow the recommendations of ASHRAE Guideline 1.1.
2. Control system manufacturer's recommended training.
3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.

F. Training Manuals: See Section 01 7900 for additional requirements.
1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.

B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

PART 3 EXECUTION

3.01 PREPARATION

A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.

B. Furnish additional information requested by the Commissioning Authority.

C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.

D. Notify the Commissioning Authority when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.

E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.

F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.

G. Provide temperature and pressure taps in accordance with Contract Documents.

3.02 INSPECTING AND TESTING - GENERAL

A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.

B. Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.

C. Provide two-way radios for use during the testing.

D. Valve/Damper Stroke Setup and Check:
   1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
   2. Set pump/fan to normal operating mode.
   3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
   4. Command valve/damper open; verify position is full open and adjust output signal as required.
   5. Command valve/damper to a few intermediate positions.
   6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

E. Isolation Valve or System Valve Leak Check: For valves not by coils.
   1. With full pressure in the system, command valve closed.
   2. Use an ultra-sonic flow meter to detect flow or leakage.

F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.03 TAB COORDINATION

A. TAB: Testing, adjusting, and balancing of HVAC.

B. Coordinate commissioning schedule with TAB schedule.

C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.

D. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.

E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.

F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

3.04 CONTROL SYSTEM FUNCTIONAL TESTING

A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.

B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.

C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.

D. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
   1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
   2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.

E. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.

F. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
   1. Setpoint changing features and functions.
   2. Sensor calibrations.

G. Demonstrate to the Commissioning Authority:
   1. That all specified functions and features are set up, debugged and fully operable.
   2. That scheduling features are fully functional and setup, including holidays.
   3. That all graphic screens and value readouts are completed.
   4. Correct date and time setting in central computer.
   5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
   6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
   7. Power failure and battery backup and power-up restart functions.
   8. Global commands features.
   9. Security and access codes.
   10. Occupant over-rides (manual, telephone, key, keypad, etc.).
   11. O&M schedules and alarms.

12. Occupancy sensors and controls.
13. All control strategies and sequences not tested during controlled equipment testing.

H. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.05 OPERATION AND MAINTENANCE MANUALS

A. See Section 01 7800 for additional requirements.

B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.

C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.06 DEMONSTRATION AND TRAINING

A. See Section 01 7900 for additional requirements.

B. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.

D. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:

E. TAB Review: Instruct Owner's personnel for minimum [____] hours, after completion of TAB, on the following:
1. Review final TAB report, explaining the layout and meanings of each data type.
2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
5. Other salient information that may be useful for facility operations, relative to TAB.

F. HVAC Control System Training: Perform training in at least three phases:
1. Phase 1 - Basic Control System: Provide minimum of [____] hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
   a. This training may be held on-site or at the manufacturer's facility.
   b. If held off-site, the training may occur prior to final completion of the system installation.
   c. For off-site training, Contractor shall pay expenses of up to two attendees.
2. Phase 2 - Integrating with HVAC Systems: Provide minimum of [____] hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:

a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
d. Every display screen, allowing time for questions.
e. Point database entry and modifications.

3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of [____] hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.

G. Provide the services of manufacturer representatives to assist instructors where necessary.

H. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION

SECTION 23 0913
INSTRUMENTATION AND CONTROL FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. This Section details the requirements of the projects Building Management System (BMS), utilizing Direct Digital Controls (DDC) based control equipment for HVAC systems and components, including control components for units not supplied with factory provided controls.

1.03 RELATED SECTIONS

A. The Drawings and the General Provisions of the Contract, including General, Supplementary, and Special Conditions, and Division 1 - General Requirements, apply to work specified in this section. The BMS contractor shall familiarize himself with the terms of the above documents and any sections hereinafter referred to that affect this work. If the BMS contractor believes there are conflicts or missing information in the project documents, the BMS contractor shall promptly request clarification and instruction from the A-E design team.

B. Sections include the following:
   1. Section 23 0993 - Sequence of Operations for Controls
   2. Section 26 0502 - Basic Electrical Requirements
   3. Section 26 0533 - Raceway and Boxes for Electrical Systems
   4. Section 26 0519 - Low Voltage Electrical Power Conductors and Cables
   5. Section 26 2726 - Wiring Devices
   6. Section 28 3116 - Fire Alarm System

1.04 RELATED WORK SPECIFIED ELSEWHERE

A. Related Sections include the following:
   1. Project Drawings, Mechanical; BMS Diagrammatic Details
   2. Section 23 2113 - Hydronic Piping
   3. Section 23 3600 - Air Terminal Units
   4. Section 23 8200 - Convection Heating, and Cooling Units
   5. Section 23 3100 - HVAC Ducts, and Casings
   6. Section 23 0593 - Testing, Adjusting and Balancing For HVAC

B. Products Supplied, but Not Installed Under This Section:
   1. Automatic Control Valves
   2. Airflow Measuring Devices
   3. Thermowells, sockets and other hardware for water sensors.

C. Products Not Supplied, but Installed Under This Section:
   1. Unit Manufacturer field mounted sensors
   2. Unit Manufacturer network communications wiring
   3. Boiler Control Panels and components

D. Products Not Supplied or Installed, but Integrated with the Work of This Section:
   1. Unit Manufacturer equipment controls
   2. Boiler control panels and systems
   3. Pump control packages
   4. Fire Alarm Control Panel
   5. Fire Alarm Zone Alarm Module Relays

6. Smoke Detectors (alarm relay contact monitoring).

E. Work Provided by Others, Required Under Other Divisions, Related to This Section:
   1. Section 28 3116 - Fire Alarm System
   2. Division 26 Electrical power wiring to the line side of motor starters, disconnects or variable frequency drives.
   3. Division 26 Electrical Provide and wiring of smoke detectors and other devices relating to fire alarm system.
   4. LAN (Ethernet) connections adjacent to SNC (JACE) network management controls

1.05 SYSTEM DESCRIPTION

A. This section contains the design intent and functionality of the Building Management System. The Building Management System (BMS) shall provide the Direct Digital Control (DDC), for the heating and cooling air conditioning systems and shall interface with other building microprocessor based subsystems as shown on the project documents, points lists, drawings and as described in these specifications. This scope of work shall include a complete and working system including all engineering, programming, controls and installation materials, installation labor, commissioning and start-up, training, final project documentation and warranty.

B. Project Drawings and Specifications: The work of the single BMS Contractor shall be as defined individually and collectively in all Sections of this Division's specifications together with the associated project drawings and the associated interfacing work as referenced in the related documents. The project BMS diagrams and drawings are diagrammatic only and shall not be utilized for installation configuration or mounting.

C. Design Intent:
   1. The intent of this specification is to provide an Open Source – Open System Platform that is consistent with BMS systems throughout the owner's facilities running the Niagara 4 Framework.
   2. The Building Management System architecture shall fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, as a minimum, LonTalk, BACnet and Modbus.
   3. An Open System architecture shall provide secure Web access using MS Internet Explorer from any computer on the owner's LAN.
   4. All control devices furnished with this Section shall be programmable directly from the Niagara 4 Workbench upon completion of this project. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable.
   5. Only systems that utilize the Niagara 4 Framework shall satisfy the requirements of this section. Any control vendor that shall provide additional BMS server software shall be unacceptable.
   6. The BMS server shall host all graphic files for the control system.
   7. Include engineering/programming software to modify Operating System Server BMS programs and graphics. The Owner shall receive all Administrator level login and passwords for engineering toolset at first training session. The Owner shall have full licensing and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS.
   8. The BMS Contractor shall maintain the integrity of the existing BMS system during switchover. There shall be no blackout periods.
   9. All work in tenant space or adversely affecting tenants shall be performed after-hours.

D. Building Management System Design: All material and equipment shall be standard components, regularly manufactured for this and/or other systems and not custom designed specifically for this project. All devices and components shall have been thoroughly tested and proven in actual use for at least two years prior to this project. The Building Management System shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator interface devices. The design shall be by the contractor's in-house engineers. Furnish all labor, materials, and equipment necessary for a complete and operating Building Management System (BMS), based on the Niagara 4 utilizing Open Source and Open System Direct Digital Controls as shown on the drawings and as described herein. The BMS control details on the project drawings are diagrammatic only are meant to assist the BMS contractor in the overall scope and are not to be construed as all inclusive. . All controllers furnished in this section shall communicate on a peer-to-peer bus using the BACnet protocols.

E. Single Fault Independence: The Building Management System network riser architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each Niagara 4 DDC controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming, and trending function, or any function at any operator interface device.

F. Peer-to-Peer Communications - Provide a peer-to-peer networked, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet technology in one open, interoperable system. Only ANSI/ASHRAE Standard 135-2001 BACnet is acceptable for the peer-to-peer network. Controllers shall be able to access any data from, or send to control commands and alarm reports to, any other Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC Controllers shall also be able to send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device. Proprietary communication networks are not acceptable. Examples of unacceptable proprietary communication networks are (but not limited to) Johnson N2, Siemens Apogee, Alerton IBEX, Carrier Comfort Network, Trane Comm 4, Trane Comm 3, Honeywell C-Bus, Arcnet, etc. Each Supervisory Network Controller (SNC) and DDC controller shall be peer-to-peer BACnet™ Open Systems protocol communication and shall communicate via the Building Management System Wide Area Network (WAN) using BACnet™ open protocol. All monitored and controlled point information and calculations shall be accessible via any connected Web Browser.

G. Integration Communications: The Building Management System (BMS) network architecture shall fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, BACnet MS/TP; BACnet IP; LonTalk; N2; and MODBUS RTU.

H. Security: Controllers shall be able to assign password access and control priorities to each point individually. The Logon password shall enable the operator to monitor, adjust or control only the points that the operator is authorized. All other points shall not be displayed at the PC workstation or portable terminal. Passwords and priority levels for every point shall be fully programmable and adjustable.

I. Spare Capacity: All controllers shall be installed with 20% spare points (of each type) and 50% spare memory capacity.

J. Building Management System Contractor's (BMSC) Responsibility: The Building Management System Contractor (BMSC) shall prior to bidding, field verify the proposed new and existing equipment locations and quantity. The BMS contractor shall be responsible for the full quantity and scope as field conditions dictate. The BMSC shall provide a complete, neat, and

workmanlike installation using only directly employed who are skilled, experienced, trained, and familiar with the specific equipment, software, standards, and configurations to be provided for this Project. The BMSC shall manage and coordinate the BMS work in a timely manner in consideration of the Project schedules and shall coordinate with the associated work of other trades so as to not impede or delay the work of associated trades. The BMSC shall provide a complete and operating Building Management System (BMS). The Building Management System shall utilize both new and existing Direct Digital Controls as shown on the drawings and as described herein. The BMSC shall provision all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in this section which are required for the complete, fully functional Building Management System.

K. Open Source: The Building Management System shall Open Source, consisting of materials and components available through Open Source product procurement suppliers. Single source exclusivity or other conditions which inhibit the Owner from obtaining both materials and support services from less than three independent procurement avenues of shall not be acceptable.

L. Open Niagara 4 Platform: Building Management Systems that do fully utilize and conform to the Open Niagara 4 Frameworks platform through their design or require additional software tools for post installation maintenance are not acceptable.

M. Open System platform: The BMSC shall furnish and install a complete Honeywell Niagara N4 Frameworks Building Management System and an Automatic Temperature Control System including all necessary hardware, all operating and applications software necessary to perform the control sequences as called for in Section 23 09 93 “Sequence of Operation for HVAC Equipment”, BMS Diagrammatic Details, as shown on the project drawings. The new DDC controllers furnished in this section shall be an Open System platform, all programming of the shall utilize the Open Niagara N4 Platform embedded software package and communicate peer-to-peer via the Open ASHRAE 135 BACnet communications protocol. Non-BACnet compliant, exclusive transmission rates, unique variants (ARCnet 156k), propriety equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

N. Open Niagara Interface Conformance Statements (NICS): All NICS shall follow the Open Niagara Interface Conformance specifications. All Niagara 4 software licenses shall have the following NICS:
   1. "accept.station.in=*"
   2. "accept.station.out=*"
   3. "accept.wb.in=*"
   4. "accept.wb.out=*"

O. All JACE hardware licenses and certificates shall be stored on local MicroSD memory card employing encrypted “safe boot” technology. To ensure quality, any additional JACE hardware products used on this project shall come through the Tridium Richmond, VA shipping facility. JACE hardware products not meeting these requirements shall not be allowed.

P. Web-based Graphical Interface: The Owner shall provide any Thin Client Web Stations (TCWS). The Operator shall be able manage the Honeywell WEBs Building Management System through a connected Thin Client Web Station’s web-browser. The Building Management System Contractor (BMSC) shall provide 3 dimensional web graphics. Including all floor plans, new mechanical systems, boilers, pumps, fans, unit ventilators, roof top units, coils, etc. All new Building Management System (BMS) web graphics for this project shall

match the existing web graphics in design features and esthetics. All new Building Management System (BMS) web- graphics for this project shall match the existing web-graphics in design features and esthetics. The web graphic files shall reside in the individual Supervisory Network Controllers. Copies of the web graphics shall be retained in the BMS Archival Data Server.

Q. Graphics must be exclusively coded in HTML 5 and shall reside and be accessible on the controller of which the input/output is controlled, with the exception of the main site graphic, map, and index available from the supervisory station. The supervisory server will be used to create and manage all graphics; however, its accessibility will not preclude access of all graphics when on/connected to the building/site LAN.

R. Web-Based Graphics: The Building Management System shall allow operator to monitor, control and schedule the HVAC equipment from any standard web-browser over the Internet, or TCP/IP connection. The operator shall be able to interact with all 3-D Graphics, scheduling, alarming and reporting, including the graphical processes generation. All control points, parameters of the Graphical User Interface shall be on standard web-browser and shall not require any special software from the BMS manufacturer. The BMS Contractor (BMSC) shall provide 3-D customized color graphics of all new systems including:
   1. Building Floor Plans
   2. Unit Ventilator
   3. Exhaust Fans
   4. Heating & Ventilator Units
   5. Mechanical Heating Systems
   6. Fintube Radiation Controls

S. Customized Graphic Description: The customized 3-D graphics shall depict the equipment configuration, fans, coils, valve piping, locations of sensors and all controlled elements. The screen shall provide the operator control parameters and adjustments. The equipment I/O points shall be displayed in real-time and shall be dynamically updated without requiring a manual refresh of the graphics page.

T. Local and Remote Connectivity: The Building Management System shall provide the Owner with a secure remote and local access shall be through an internal TCP/IP network connection. Alarm notification to designated stations and personnel through the TCP/IP network connection.

U. Information Technology (IT) compliance and control access: The BMS shall be designed for use with the Owner's current enterprise level IT system. The BMS TCP/IP devices located in IT rooms shall be fully IT compatible devices that communicate directly on the IT infrastructure in the facility.

V. Embedded Software: All Building Management System DDC controllers furnished by the BMS Contractor shall be programmable directly from any Niagara 4 Workbench embedded toolset. The Owner shall have full licensing and full access rights for all network management, server, engineering, and programming software required for the ongoing maintenance and operation of the BMS and shall receive all Administrator level logins and passwords.

W. Equipment Manufacture Systems: Fully integrate the HVAC equipment unit manufacturer controls systems into the Building Management System via an Open communications protocol.

X. Existing System: All new BMS DDC controllers shall as a minimum, match the existing BMS architecture capabilities, or shall be installed to the latest Niagara N4 capabilities as required. Provide a Building Management System that is consistent with existing systems throughout the owner's facilities running the Niagara 4 Framework. Fully integrate the existing legacy DDC controls systems into a new Open Source - Open System Niagara Frameworks Building Management System. The existing and new building systems shall be integrated into a

distributed network system communicating over a BACnet Open Protocol communications network.

Y. Legacy Network Controllers: Remove and replace any existing legacy Building Management System Supervisory Network Controller(s) to the Niagara 4 platform.

Z. Legacy Software and Graphics: Provide all past maintenance software updates for the existing Niagara Supervisor Network Controllers to date. Upgrade the Niagara 4 graphic software, including, providing any current software patches for the existing user interface. Remediate all of the existing graphics to this Sections Graphic web-graphic standards.

AA. Legacy System Integration: The new Niagara 4 DDC controller(s) shall be a direct extension of the existing Building Management System and shall utilize the existing communications infrastructure. All of the existing Honeywell DDC devices control components shall be integrated into a single distributed BMS network, communicating over a single Honeywell Open Source – Open System BMS communications network. The Building Management System shall utilize both new and existing Direct Digital Controls as shown on the drawings and as described herein. All Building Management System manufacturers must seamlessly integrate with the existing Honeywell Controls system. The use of third party field server software shall not be acceptable.

BB. Legacy System Remediation: The Building Management System Contractor (BMSC) shall furnish all labor, materials necessary to remediate &/or repair the existing controls as outlined on the project drawings and in Section 23 09 93 of this specification.

CC. BMS Information Management including:
1. System programming
2. DDC Device downloading
3. DDC Device backup
4. BMS data archiving and retrieval
5. Data Reporting functions.
6. Standard applications for HVAC systems.
7. Diagnostic monitoring and reporting of BMS functions.
8. Offsite monitoring and management access.
9. Energy management

DD. The Building Management System shall be comprised of the following components:
1. Building Management Archival Data Server (ADS)
2. Operator Workstation(s) (OWS)
3. Thin- Client Workstation(s) (TCWS)
4. Portable Operator Terminal(s) (POT)
5. Supervisory Network Controller(s) (SNC)
6. Uninterruptable Power Supplies (UPS)
7. Network Routers, bridges, switches, hubs, interfaces, and the like equipment.
8. Web-Browser Graphics User Interface (GUI)
9. System Software Configuration Tools (SCT).
10. System Software with Embedded Graphic, Scheduling and Alarm Management
11. BACnet Building Level Controllers (B-BC) and I/O devices
12. BACnet Advanced Application Controllers (B-AAC) and I/O devices
13. BACnet Application Specific Controllers (B-ASC) and I/O devices
14. BACnet VAV Application Specific Controllers (B-ASC) and I/O devices
15. BACnet MS/TP Communications Network
16. Third party system Data Integration.
17. Additional enclosures and ancillary devices required to perform the Division 23 Section “Sequence of Operations for HVAC Equipment” and BMS Diagrammatic Details, as shown

on the project drawings

EE. Omissions: Minor details not usually shown or specified but necessary for proper installation and operations shall be included, as if herein specified and/or shown.

FF. Esoteric Omissions: The omission of hardware, firmware, and software components required to satisfy the specified configuration(s), but not specified due to the esoteric requirements of a particular manufacturer's product design shall not relieve the Building Management System Contractor from the responsibilities of providing and installing omitted apparatuses, (i.e. feed-back circuits, calibration resistors, and override detection interface devices).

1.06 NETWORK COMMUNICATIONS:

A. Fiber Optics The Building Management System Tier 1 network shall be open Fiber communicating at 1000MB, 1 Gigabit/second minimum speed. Provide 62.5/125uM high performance fiber cabling.

B. Building Network Controllers (B-BC): Building Controllers (B-BC) shall be provided for HVAC equipment and shall be networked together using CAT-6 Ethernet cable. Provide 1 Gigabit communication between BMS servers and clients. Provide 100 Megabit Peer-to-Peer communications among BACnet Building Level controller(s) (B-BC) responsible for HVAC equipment Control.
   1. Central Plant - Hot Water Systems
   2. Energy Recovery Units
   3. Roof Top Units
   4. Heating & Ventilating Units
   5. Makeup Air Units

C. Advanced Application Controllers (B-AAC): Each of the following HVAC equipment shall be controlled by an individual BTL listed Advance Application Controller (B-AAC). Advanced application controllers (B-AAC) shall communicate across a Building Level BACnet TCP/IP communications network.

D. Application Specific Controllers (B-ASC): Application Specific Controllers (B-ASC) shall communicate across a floor level BACnet MS/TP communications network.
   1. Variable Air Volume Boxes
   2. Exhaust Fans

E. Integration Communications: Provide hardware, software, and wiring to provide communication interfaces with each of the systems listed below, at location described in the project plans.
   1. Fire Alarm System
   2. Security System
   3. Lighting Controls and Panels
   4. Chillers &/or Panels
   5. Hot Water Boilers &/or Panels
   6. Variable Frequency Drives

F. Agency Approvals: The BMS shall be provided with the following agency approvals:
   1. Federal Communications Commission (FCC) Rules and Regulations, Vol II - 1986:

PART 15 CLASS A RADIO FREQUENCY DEVICES.

PART 15 SUBPART B, CLASS B

PART 15 SUBPART C

PART 15 SUBPART J, CLASS A

5.01 UNDERWRITER LABORATORIES (UL):

A. UL 506 - Specialty Transformers.

1. UL 910 - Test Method for Fire and Smoke Characteristics of Electrical and Optical Fiber Cables Used in Air Handling Spaces.
    a. UL 916 - Energy Management Systems All.
    b. UL 1449 - Transient Voltage Suppression.
2. American National Standards Institute (ANSI)
    a. ANSI 232-F – … DTE and DCE Employing Serial Binary Data Interchange.
3. Electronics Industry Alliance (EIA)
    a. EIA 455 - …Fiber Optic Fibers, Cables, Transducers …Terminating Devices.
4. Institute of Electrical and Electronic Engineers (IEEE)
    a. 1- Surge Voltages in Low Voltage AC Power Circuits.
    b. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
5. National Electrical Manufacturers Associations
    a. NEMA ST 1 - Specialty Transformers.
    b. NEMA 250 - Enclosures for Electrical Equipment.
    c. NEMA ICS 1 - Industrial Controls and Systems.
6. Conformité Européene (CE) CE 61326
7. Australian Communications Media Authority (ACMA). C-Tick
8. Canadian Standards Association (CSA) C-UL listed C22.2 “Signal Equipment”
9. China Compulsory Certificate (CCC)
10. State Radio Regulation Committee (SRCC)
11. Radio Standards Specifications (RSS)
12. Restriction of use of certain Hazardous Substances (Electrical/Electronic)(RoHS)
13. Products not currently offering the above approvals are not acceptable. \
14. Verification that the approvals exist for all submitted products shall be provided on request, with the submittal package.

5.02 SPECIFICATION NOMENCLATURE & DEFINITIONS

A. Singular usage: The use of words in the singular in this Section’s documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.

B. Interpretation Aid: Headings, paragraph numbers, titles, shading, bolding, underscores, clouds, and other symbolic interpretation aids included in this Division documents are for general information only and are to assist in the reading and interpretation of these Documents. Numerical figures are positive unless otherwise indicated as negative or minus.

C. Definitions: Acronyms may be used in describing the work of this Division, any additional unique acronyms shall be declared throughout the specifications.
    1. 10 Base T: The technical name for twisted pair Ethernet
    2. Automated Analytics: Data analysis provided by the BAS or other software system which provides a comprehensive set of functions for manipulating and analyzing data of a database obtained via data logging of a device/system. The system implementer can create analytic functions to implement rules that are appropriate for the specific characteristics and needs of their facilities, equipment, processes, and project scope to determine if the system is operating per the design intent/sequence of operations or not. Alarms, notifications, and reports are a used to inform users of off normal conditions which deserve attention for corrective action. (See Data Logging and Trend Analysis)
    3. Actuator: A control device that opens or closes valve or damper in response to control signal.
    4. Algorithm: A logical procedure for solving a recurrent mathematical problem; A prescribed set of well-defined rules or processes for the solution of a problem in a finite number of

steps.

5. Analog: A continuously variable system or value not having discrete levels. Signals which are continuous and represent control influences such as flow, level, moisture, pressure, and temperature.
6. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
7. BACnet Testing Laboratories (BTL): An organization under the direction of BACnet International responsible for testing products for compliance with ASHRAE 135.
8. Baud: A signal change in a communication link. One signal change can represent one or more bits of information. Peripheral communication is normally one bit per Baud. e.g., Baud rate = 78,000 Baud/sec is 78,000 bits/sec.
9. BIBBS: BACNET Interoperability Building Blocks
10. Binary: A two state condition, i.e. “ON” or “OFF”. Signals which are either constant or digital pulse (values) and generally represent two-position operating and alarm status.
11. Bridge: A device that connects two or more LAN segments at the physical and data link layers. This device may also perform message filtering if programmed to do so.
12. Browser: A computer program that accesses and displays information from the Internet or intranet.
13. Category 6 cable: A type of wiring used for twisted pair Ethernet. The electrical characteristics of Cat 6 wiring make it less susceptible to electrical interference than lower categories.
14. Client: A system or device that makes use of another device for some particular purpose through a system request.
15. Building Management System (BMS): The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this Division’s BMS Contractor and to the interface of the associated work of other related trades. The complete digital online real time interconnected configuration of digital processing units, workstations, panels, sub-panels, controllers, devices, and associated network nodes.
16. Building Management System Contractor (BMSC): The single contractor to provide the work of this Section. This BMS contractor shall be the primary designer of the system manufacturer, installer, commissioner, and ongoing service provider for the BMS work.
17. Communication Bus Topologies:
    a. Ethernet: A system for exchanging data between computers on a network using coaxial, fiber optic, or twisted-pair cables.
    b. Local Area Network (LAN): A local internal communication bus structure that exchanges information between networked computers or devices.
    c. LonWorks: A communications bus topology that utilize the open LonTalk protocol. Niagara Frameworks platform: A Building Management System architecture which is utilized across various system manufacturers, providing an Open common technological design. This platform provides the Building Management System with capabilities to support multi-vendor systems. The system utilizes multiple standard Open protocols as well as the ability for integration of third-party systems via existing proprietary protocols.
    d. Peer to Peer: A communication bus topology where all network devices are treated as equal. Each device connected has equal status and shares its data directly with all other network connected devices.
18. Communication Protocols: A defined set of standards governing exchange of data between network devices.

a. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
b. BACnet/IP: A BACnet protocol which defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is one or more IP subnetworks with the same BACnet network number.
c. I/P: Internet Protocol network, connecting workstations and other host computers, servers etc. to share the information.
d. LonTalk: An open standard protocol that uses a "Neuron Chip" for communication.
e. Modbus TCP/IP: An open protocol for exchange of data over a TCP/IP network.
f. MS/TP (EIA485): Master-slave/token-passing, IEE 8802-3. Datalink Protocol LAN option that uses twisted-pair wire for low-speed communication.
g. TCP/IP: Transport control protocol/Internet protocol.

19. Conformance Classes: The set of requirements to be met in order for a device to conform to BACnet. BACnet defines six (6) levels of required support for standard objects and services. The higher the Conformance Class, the greater number of services provided.
20. Control Devices: Valves, dampers, variable frequency drives, and other appurtenances that change the properties and henceforth vary the conditions of the controlled parameter, such as temperature, air flow, pressure, etc.
21. Controlled Parameter: Air, water, glycol, steam, or other media whose conditions are maintained or varied by the automatic control system and the control devices.
22. Contract Terms used in this specification section shall mean:
    a. Furnish: To supply at the contractor's cost to a designated third party contractor for installation. The contractor shall connect furnished items to the BMS, calibrate, test, commission, warrant and document.
    b. Install: To receive at the jobsite and mount.
    c. Provide: To Furnish, Install in place, connect, calibrate, test, commission, warrant, document, and supply services for operation.
    d. Wire: To Install the electric conductors and terminations.
    e. Wiring: the low voltage network or control wiring and terminations.
23. Control Loop: A control algorithm, with an analog input/output
24. Data Logging: Population of a database of data obtained from an electronic device that records data over time or in relation to location with an instrument or sensor or via external instruments and sensors. (See Automated Analytics and Trend Analysis)
25. Data Link Layer: Part of the Protocol Stack. The layer resides between the Physical Layer and the Network Layer. It passes to the Network Layer only acceptable incoming BACnet messages received from the Physical Layer. The Data Link Layer is responsible for adding a code to outgoing messages to identify them as BACnet messages before passing them on to the Physical Layer.
26. DDE: Dynamic Data Exchange.
27. Deadband: An analog range over which no change of state occurs.
28. Device (BACnet): A device, real or virtual, that supports digital communication using the BACnet protocol. Examples would be an operator terminal, router, unitary controller, etc.
29. Direct Digital Control (DDC): The programmed algorithms and software to provide direct closed loop control for equipment and controlled variables. Inclusive of Proportional, Derivative & Integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.
30. Direct Digital Controller (DDC): A generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Types of DDC controllers are Building Controller (B-BC); Advanced Application Controller (B-AAC); Application-Specific Controller (B-ASC).

31. Distributed Control: Processing of system data is decentralized, and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.
32. Distributed Control System: A system in which the processing of system data is decentralized, and control decisions are made at the subsystem level.
33. Download: The transfer of programs and data files from a source to a remote device.
34. Electrical Control: A control circuit that operates online or low voltage and uses a mechanical means to perform control functions. i.e. temperature sensitive bimetal or bellows, a switch, or a potentiometer.
35. Electronic Control: A control circuit that operates on low voltage, using solid state component to amplify input signals and perform control function.
36. Ethernet: Ethernet is a widely used Local Area Network (LAN). Ethernet, which conforms to IEEE Standard 802.3.
37. Events: Changes in the state of an object, typically between Normal, Off-Normal, and Fault Condition. Events may be reported to other BACnet devices.
38. Fiber: An abbreviation for optical fiber.
39. Firewall: A security mechanism placed at the connection between networks and/or at networks outside connections. The firewall restricts access to the network.
40. Firmware: Software programmed into read only memory (ROM) chips which may not be changed without physically alteration.
41. Floating: A timed digital signal typically used to simulate a true Analog value.
42. FTT-10: Echelon Transmitter-Free Topology Transceiver.
43. Fully Open BAS: Building Automation System that all materials, hardware, firmware, software, and licenses can be procured through open market non-proprietary vendor warehouse distribution channels; in addition to being installed and maintained by any JACE factory authorized/qualified Building Automation and Controls Company. Single/sole vendor source materials, hardware, firmware, software, and licenses are prohibited from installation on this project.
44. Graphic Sequence of Operation: A graphic software programming language of algorithms, logical computation, target values and limits as required to obtain the defined control objectives. A dynamic graphical representation of the sequence of operation, showing all inputs and output logical blocks.
45. Graphic Web Page: A Web-browser page using 3-dimensional color-coded, animated images, which represents the associated system or equipment. This consists of all I/O points and control parameters for monitoring and operation of the equipment.
46. Gbps: Gigabits per second. A unit of data transfer speed equal to 1024 Mbps.
47. GIF: Graphic Interchange Format: A standardized image standard.
48. GUI: Graphical User Interface, a type of Operator Interface Device for a BAS.
49. Integration: The complete functional, operational, and interfacing of a third party equipment, including monitoring and control elements; to incorporate the third party equipment into a single coherent system as required by this Division.
50. Half Router: A device or node that can participate as one partner in an RS-232 point-to-point (PTP) connection. The Half Router partners that form an active PTP connection act as a single router for as long as the PTP connection between the two is active.
51. Hardware address: The address assigned to a computer or DDC controller that attaches to a network. A data frame sent from one hardware device to another hardware device must contain the recipient's address. A hardware address is also called the physical address.
52. Hertz: A unit of measure equal to an oscillation per second.

53. HTML: The source form used for documents on the Internet or on an intranet. HTML embeds commands that determine formatting along with the text to be displayed.
54. Instance: A number which uniquely identifies an object within a device (e.g., Analog Input No.1, No. 2, etc.). Device Objects are required to have an instance number that is unique to their internetwork. Instance numbers may range from 0 to 4194303.
55. Input/Output (I/O): Building Management System through which information is received or transmitted. An analog or discrete instances with an addressable database value, includes Analog input (AI), Binary input (BI), Analog output (AO), Binary output (BO).
56. I/P: Internet Protocol. The protocol that defines both the format of packets used on a TCP/IP internet or intranet and the mechanism for routing a packet to its destination.
57. Internetwork: Two or more networks connected by routers (the Internet itself and internetwork), up to 65,535 interconnected networks are allowed by BACnet. A BACnet internetwork provides only one message path between two devices. Internetworks may contain similar or dissimilar physical types, so an internetwork may consist of two Ethernet LANs, or an Ethernet LAN and several MS/TP LANs, etc.
58. Intranet: A computer network with restricted access, as within a corporation, that uses software and protocols developed for the Internet.
59. Java: A programming language defined by Sun Microsystems for use in Internets.
60. JACE: JAVA Application Control Engine.
61. JPEG: Joint Photographic Experts Group: A standardized image compression standard.
62. LAN: A LAN is a network of interconnected hardware devices sharing resources within a relatively small geographic area.
63. LPDU: Link Protocol Data Units are packets created and read by the Data Link Layer. They contain a 3-byte header which identifies the packets as having been created by, and intended to be read by, a BACnet system. The header is followed by the BACnet LPDU.
64. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
65. MTBF: Mean time between failures.
66. Operating System (OS): Software, which controls the execution of computer application programs.
67. MS/TP: The Master-Slave/Token-Passing EIA-485 LAN developed for BACnet by ASHRAE. Operates at 9600, 19.2K, 38.4K and 76.8 K BPS. Master nodes (devices) pass around a speaking token which entitles the holder to initiate BACnet messages. Slave nodes can only respond to messages from Masters.
68. Native BACnet: A Building Automation System that uses the BACnet protocol for its data transfer between hardware devices.
69. Network Repeater: A device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
70. NIST: The National Institute of Standards and Technology is developing a BACnet device-compliance testing facility in Gaithersburg, MD.
71. NODE: A computer or digital device connected to a network, with an address on that network.
72. OBJECT (BACnet): BACnet objects represent, in a standardized way, the information required for a building automation control system. The analog input object, for example, represents sensor inputs such as temperature sensors.
73. Optical Carrier (OC): A set of standards adopted by common carriers for the high-speed transmission of digital information over optical fiber.
74. Optical fiber: Glass fiber used in digital networks.
75. Optical modem: A modem that uses modulated light waves to provide digital communication.

76. Object Identifier: A 32-bit number which uniquely identifies an object within a device, or the device object internetwork-wide. 10 bits represent the object type and 22 bits the instance number.
77. OSI: Open System Interconnection standards.
78. Packet: A small, self-contained parcel of data sent across a digital network.
79. PAD (Packet-Assembler-Disassemblers): A device that sends BACnet messages across BACnet incompatible networks. The sending PAD receives the message from a BACnet network, encapsulates it in the correct format, and sends it on the non-compatible network to a receiving PAD. The receiving PAD removes the message from its encapsulation and transmits it on another BACnet network.
80. PC: Personal Computer.
81. PCX: File type for a photograph image file.
82. Peripheral: Individual components which support the system and provide ancillary functions i.e. monitor, printer, and I/O unit.
83. Peer-to-Peer Communication: Communication between equals. In BACnet, application programs (performing the functions of the BACnet devices on which they run) in devices of the appropriate conformance class talk to each other as peers, using the Protocol Stacks to deliver their message to each other. Likewise, Network Layers may talk as peers to determine how to route messages.
84. Physical Segment: A single continuous medium 9-wire to which BACnet nodes are attached.
85. Property: A particular characteristic of a BACnet object. Examples of properties are Description (a text description of what the object represents, such as OSA for outside air, and analog input object), Present Value (22 for the same input) and engineering units (degrees Celsius).
86. Proportional Integral Derivation (P-I-D):
    a. Proportional control (P) control mode with continuous linear relationship between observed input signal and final controlled output element,
    b. Integral control (I) an additional change in output based on both amount and duration of change in controlled variable
    c. Derivative (D) correction to the controlled variable as sensed by its rate of change.
87. Protocol Implementation Conformance Statement (PICS): A document that identifies the particular BACnet options that are implemented in a device.
88. PTP: The Point-To-Point protocol provides serial communications between two BACnet half-router devices, typically for dial-up communications over-the-phone modems. It may be also applied as a hard-wired interface. For the duration of the connections, messages may be passed between networks on either side of the PTP connections.
89. Repeater: A device that connects two or more physical segments of a LAN at the physical layer and exactly reproduces the electrical signals on either side so that nodes on either side of the repeater are considered to be on the same network.
90. Router: A device which connects two or more networks, of same or different types, so that a BACnet message may be transferred across the appropriate networks to reach its destination.
91. RS-232-C: The technical name of the standard for serial data connections such as those between a computer and a keyboard.
92. Server: A computer or hardware device which stores the resources accessed by other computers or hardware devices (clients).
93. Services (BACnet): BACnet defines 26 standard services; some services read or write properties of objects in the receiving device, others convey notification of alarms or other special events, others read and write files, and so on.

94. SNMP: Simple Network Management Protocol. The protocol that specifies how a network management station communicates with agent software in remote devices such as routers. SNMP defines the format of messages and their meaning.
95. SMTP: Simple Mail Transfer Protocol. E-mail or text message application. Often resides on a server.
96. Software: All of operating system and programming of the BMS DDC firmware, sequence programming, database entries and definitions.
97. Supervisory Network Controller (SNC): A Direct Digital Controller which supports Building Controller (B-BC), Advanced Application Controller (B-AAC), Application-Specific Controller (B-ASC), and which communicates on a peer-to-peer network for transmission of global data.
98. TCP/IP: The protocol suite used in the Internet. Although the suite contains many protocols, TCP and IP are two of the most important.
99. Thinnet: A term used for the version of Ethernet that uses thinner coaxial cable.
100. Thin-client architecture: A term used to describe server/client system architectures in which one or more powerful hardware devices (servers) store the resources accessed by other less powerful hardware devices (clients).
101. Token Ring Network: A Token Ring Network is a Local Area Network (LAN) in which each of the computers are connected in a ring or a star topology and a bit, or a token-passing scheme, is used in order to prevent the collision of data between two computers that want to send messages at the same time. The token ring protocol is the second most widely used pattern after the Ethernet. A typical arrangement is as follows:
    a. Empty information frames are continuously circulated on the ring;
    b. When a computer has a message to send, it inserts a token in an empty frame (this may consist of simply changing a 0 to a 1 in the token bit of the frame) and inserts a message and a destination identifier in the frame;
    c. The frame is then examined by each successive workstation. If the workstation sees that it is the destination for the message, it copies the message from the frame and changes the token back to 0. When the frame gets back to the originator, it sees the token has been changed to 0 and the message has been copied and received. It removes the message from the frame. The frame continues to circulate as an empty frame, ready to be taken by workstation when it has a message to send.
102. TP Ethernet: Twisted pair Ethernet.
103. Trend Analysis: A presentation of selected live or recorded data points which is aimed at projecting both current and future movement of events through use of time series data analysis which involves comparison of data over a sequential period of time to spot a pattern or trend. (See Automated Analytics and Data Logging)
104. Unitary Controller: Devices which controls and/or monitors a single piece of equipment.
105. WEB: A synonym for the World Wide Web. In modern usage pertains to both the Internet and to intranets using the TCP/IP Protocol.

D. Acronyms: Acronyms may be used in describing the work of this Division, any additional acronyms shall be declared throughout the specifications:
    1. Organization and project entities abbreviations
        a. - Automatic Temperature Controls
        b. - American Society of Heating, Refrigeration & Air Conditioning Engineers
        c. - Division 23 BMS or ATC Contractor
        d. - Building Management System
        e. - Division 26 Electrical Contractor
        f. - General Contractor
        g. - Institute of Electrical and Electronics Engineers
        h. - Division 23 Mechanical Contractor

i. - Division 23 Sheet Metal Contractor
j. - Unit Manufacturer, Equipment

2. Direct Digital Controls abbreviations
   a. - Analog Input / Analog Output
   b. - Configurable Input / Configurable Output
   c. - Digital Input / Digital Output
   d. - Direct Digital Control
   e. - Fail Open / Fail Closed
   f. - Input / Output point
   g. - Normally Open / Normally Closed
3. Computer or Electronics abbreviations
   a. - Central Processing Unit
   b. - Electronic Erasable Programable Read Only Memory
   c. - Graphical User Interface
   d. - Local Area Network/Wide Area Network
   e. - Operator Workstation / Personal Computer
   f. - Random Access Memory / Read Only Memory
   g. - Uninterruptible Power Supply
4. Heating Plant Abbreviations
   a. - Boiler, Hot Water or Low Pressure Steam
   b. - Boiler Hot Water Pump, Inline
   c. - Hot Water Pump
   d. - Hot Water Supply/Return
   e. - Heat Exchanger
   f. - Low Pressure Steam
   g. - Mechanical Equipment Room
5. Major HVAC Equipment Abbreviations
   a. - Energy Recovery Ventilator
   b. - Makeup Air Unit
   c. - Roof Top Unit
6. Ancillary HVAC Equipment Abbreviations
   a. - Baseboard Radiation
   b. - Constant Air Volume Box
   c. - Cabinet Unit Heater
   d. - Exhaust Fan
   e. - Fan Powered/Variable Air Volume
   f. - Fintube Radiation
   g. - Hot Water Coil, Duct
   h. - Reheat Coil, Duct
   i. - Unit Heater
   j. - Variable Air Volume Box
7. Field Devices Abbreviations
   a. - 2 Way or 3 way
   b. - Thermostat, Pipe mounted (Binary)
   c. - Current Transducer (Analog)
   d. - Current Switch (Binary)
   e. - Constant Air Volume
   f. - Flow Coefficient of a Control Valve
   g. - Fire/Smoke Damper

h. - Fire Alarm System/
i. - Fire Alarm Control Panel
j. - Hand-Off-Auto
k. - End Switch
l. - Liquid Detection Switch
m. - Liquid Crystal Display
n. - Light Emitting Diode
o. - Low Limit Temperature Switch
p. - Actuator, Electronic
q. - Actuator Operated Damper
r. - Motor Starter
s. - Variable Frequency Drive
t. - Occupancy Sensor
u. - Pressure Differential Transducer (Analog)
v. - Pressure Differential Switch (Binary)
w. - Control Pilot Relay
x. - Smoke Damper
y. - Smoke Duct Detector
z. - Single Pole Double Throw
aa. - Single Pole Single Throw
bb. - Double Pole Double Throw
cc. - Double Pole Single Throw
dd. - Switch
ee. - Temperature
ff. - Temperature Sensor (Analog)
gg. - Thermostat switch (Binary)
hh. - Self-contained control valve
ii. - Valve, Temperature Control

8. Power and Energy Abbreviations
   a. - American Wire Gauge
   b. - Watt
   c. - Kilowatt
   d. - Kilowatt-Hour
   e. - milli-Ampere / Ampere
   f. - Voltage-Ampere
   g. - Volts, Alternating Current
   h. - Volts, Direct Current
9. Project delineation and information Abbreviations
   a. - Not in Contract
   b. - Furnished by Others
   c. - To Be Advised
   d. - To Be Determined
10. Common Media Abbreviations
   a. - Discharge Air
   b. - Mixed Air
   c. - Outdoor Air
   d. - Return Air
   e. - Supply Air
   f. - Carbon Monoxide

g. - Carbon Dioxide
h. - Relative Humidity
i. - Temperature

5.03 COORDINATION AND WORK RESPONSIBILITY AND MATRIX

A. The demarcation of work and responsibilities between the BMS Contractor and other related trades shall be as outlined in the “Coordination and Work Responsibility Matrix” below:

Coordination and Work Responsibility Matrix			Low Voltage	Line or Power
Work Description	Furnish	Install	Wiring	Wiring
BMS control wiring	BMS	BMS	BMS	BMS
BMS communications wiring	BMS	BMS	BMS	-
BMS enclosures	BMS	BMS	BMS	26
BMS conduits and raceway	BMS	BMS	-	-
Equipment Interface	UM	BMS	BMS	-
Energy Recovery Ventilator controls	UM	UM	BMS	
Roof Top Unit controls	UM	UM	BMS	26
Cabinet Unit Heater controls (Hydronic)	BMS	BMS	BMS	26
Unit Heater controls	BMS	BMS	BMS	26
Convector controls	BMS	UM	BMS	26
VAV box controls	BMS	UM	BMS	26
Control Panels (Wall)	BMS	BMS	BMS	26*
Control Dampers – External to units	23	23	-	-
Control Dampers Actuators	23	BMS	BMS	-
Fire Dampers	23	23	-	-
Fire/Smoke Dampers	23	23	26	26
Pipe insertion devices and taps	BMS	23	-	-
Concrete equipment pads	23	23	-	-
Seismic bracing	23	23	-	-
Control Valves and Actuator	23*	23	BMS	-
Manual Valves	23	23	-	-
Boiler Control wiring	BMS	BMS	BMS	BMS
Boiler Isolation Control Valves	UM	23	BMS	BMS
MER Shutdown Pull Stations & wiring	26	26	26	26
MER Gas Monitors (Type Specific)	23	BMS	BMS	26
Variable Frequency Drives - Pumps	23	26	BMS	26
Motor Starters	23	26	BMS	26
Smoke & Heat Detectors	26	26	26	26
Fire Alarm Shutdown wiring	26	26	26	26

Fire Alarm Control wiring	26	26	26	26
Fire Alarm Control Panel (FACP)	26	26	26	26
*Reference Equipment Unit Schedule and specification, BMS Diagrams and Specification Section 23 09 93. Responsibility or work is additionally specified under separate subsections.				

23	Division 23 Mechanical Contractor
26	Division 26 Electrical Contractor
BMS	Division 23 Building Management System Contractor
SM	Division 23 Sheet Metal Contractor
UM	Equipment Unit Manufacturer

B. The Building Management System contractor shall provide electrical work as required in the specification, including:
   1. Installation of all control wiring by a licensed Electrical Contractor.
   2. All Building Management System electrical work, except as otherwise specified, or shown on the Division 26 Electrical specifications or drawings.
   3. Installation of control wiring may include line voltage and low voltage wiring, as required.
   4. Power wiring (120VAC) for the Building Management System, including control panels, DDC controllers, actuators, and sensors from a designated circuit furnished by the Division 26 Electrical Contractor.
   5. All control wiring in mechanical equipment spaces shall be installed in EMT. The conduit for power systems may be used for running control line voltage wiring. Low voltage plenum rated wiring can be run exposed above accessible ceiling and shall be supported per code and not laid on ceiling tile grid.
   6. Low voltage wiring shall be concealed in finished rooms. If any wiring must be exposed in rooms, it shall be installed in wiremold raceway.
   7. A monitoring point from the smoke detectors to the DDC controller for status. Where multiple detectors are provided, one signal shall be provided.
   8. Coordinate location of thermostats, humidistats, and other exposed control sensors with flow diagrams and sequence of operation and points list before installation.
   9. All safety devices wiring through the Hand and Auto positions of motor starting devices.

C. The Division 26 Electrical Contractor Work shall be responsible for:
   1. All interlock and wiring on the Division 26 Electrical specifications or drawings.
   2. Coordination with the BMS Contractor for any required field control panel circuit feeds.
   3. The Electrical Contractor, as part of his contract, shall provide 1P-20A circuit breakers in the power and lighting distribution panels. See electrical drawings for panel board locations.
   4. All power wiring to motors, heat trace, junction boxes for power to BMS panels.
   5. All work related to smoke detectors and smoke dampers, and fire alarm system.

D. The Division 23 Mechanical / Waterside Contractor shall be responsible for:
   1. The installation of automatic control valves.
   2. The installation of thread-o-lets and thermowells for the BMS sensors.
   3. The installation of flow meters or switches.
   4. The installation of pressure sensor taps and associated shut-off/bypass cocks.
   5. The setting of dampers and necessary blank off plates.
   6. Any access doors where and as required.
   7. The setting of airflow measuring stations.
   8. The setting of duct smoke detectors.
   9. The installation of any other devices required in the piping portion of the HVAC contract.

10. Any motor starters furnished by the Mechanical Contractor shall have control transformers and one set of auxiliary contacts, as required for interlocks.

E. Division 23 Sheet Metal / Airside Contractor shall be responsible for:
   1. The Provision and Installation of automatic control dampers, external to the equipment.
   2. The Provision and installation of smoke dampers.
   3. The Installation of duct smoke detectors.
   4. The Installation of airflow measuring stations.
   5. The Installation of other devices required to be installed into the ductwork portion of the HVAC contract and as otherwise determined by tradeline jurisdictions.
   6. The Provision and Installation of access doors where and as required.
   7. All control dampers that are external to equipment shall be provided by the sheet metal contractor. All control dampers internal to equipment shall be provided by the unit manufacturer.

5.04 PROJECT SITE CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work shall be carried out in an orderly fashion. It shall be the BMS Contractor's responsibility to check the Project and Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct, and conduit runs, electrical outlets and fixtures, air diffusers and structural and architectural features. The BMS Contractor shall repair any damage caused by his work to the building(s) and equipment at no additional cost to the owner.

B. Project Sequencing: Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

C. Component Installation: Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

D. Power Source: Coordinate the supply of conditioned electrical branch circuits for control units and operator workstation with the Division 26 Electrical contractor. Coordinate equipment with the appropriate Divisions of the Electrical Specifications for Power, Wiring, Conduit, Fire Alarm, Motor Control Centers, etc. to achieve compliance, compatibility, and interfaces.

E. Third Party BMS Integration: Coordinate equipment with the appropriate Divisions of the Mechanical Specifications for Motor Controllers, Manufacturer Supplied Controls, etc. to achieve compliance, compatibility, and interfaces.

F. Changes in Scope of Work: Any changes in the scope of work must be authorized by a written Change Order, and issued by the customer, in accordance with Contract conditions.

G. Correction of Work: The BMS Contractor shall promptly correct all BMS work found to be defective or failing to conform to the Contract Documents at no additional cost.

5.05 PERFORMANCE STANDARDS

A. Standard Material/Products: All material and equipment used shall be standard components, regularly manufactured and available, and not custom designed especially for this project

B. Modular Design: The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.

C. Performance: The system, upon completion of the installation and prior to acceptance of the project, shall perform all operating functions as detailed in this specification.

D. Single System Architecture: The Building Management System shall be consistent with BMS system throughout the owner's facilities running the Niagara 4 Framework. The BMS shall fully integrate the unit manufacturer HVAC controls systems into a new Open Source - Open System Niagara Frameworks BMS.

E. Open Source Products: All BMS DDC controllers shall be available through multiple avenues for procurement and from multiple sources. The owner shall have at least three independent sources for obtaining Building Management System devices and product. Single source, unit manufacturer provided, or territorial limitations are unacceptable.

F. Open Protocol Communications (Open System): The Building Management System (BMS) shall utilize the ASHRAE-135 BACnet Open protocol technology throughout the BMS network Hierarchy. The entire Building Management System shall be in compliance with the ANSI/ASHRAE 135 BACnet standard. The Building Management System (BMS) shall use BACnet protocols and LAN types throughout and exclusively. Non-BACnet compliant or propriety equipment or systems (including gateways) shall not be acceptable and are specifically prohibited. The Building Management System (BMS) shall conform to the industry network standards utilizing TCP/IP connections

G. Open Source Web Based Direct Digital Controls: The Building Management System (BMS) shall consist of Open Source BACnet Direct Digital Controllers (DDC). All of the BACnet DDC controllers shall be integrated into a distributed network system communicating over a single communications network. All web graphics shall be generated for interface with a standard web browser. The Operator shall interface with the Building Management System from any standard browser over a TCP/IP connection, including over the Internet. All programming and system software shall be licensed to the Owner with full password capability and access. Under no circumstances shall any part of the Building Management System or software be licensed or controlled by the Building Management System Contractor (BMSC). Upon completion of the project, the Building Management System Contractor (BMSC) shall provide to the Owner the entire programming software including original installation discs.

H. Web Based Customized 3-Dimensional Color Graphics: The Building Management System shall be tested using manufacturer's recommended hardware and software for Operator Workstation (Web Server and web browser). All Web Based Graphics shall be generated on the workstation for use over the Web. The web browser shall depict the equipment’s animated graphics, scheduler graphics, alarm screens, point and click setpoint adjustments, point and click alarm acknowledgements and resets and other graphics displays required by Operator. The Building Management System (BMS) System architecture shall provide secure Web access using any of the current versions of web browsers from any computer on the Owner's LAN. The BMS connected equipment to be monitored, controlled, and scheduled from web client computers onsite and remote sites. The units shall be dynamically depicted in 3 dimension aspect, with animated components in real time. All BMS interface points shall be on standard PC web browsers that do not require any special software from the BMS manufacturer for use as a GUI.

I. Web Graphic Display: The Graphics screens may have up to 20 dynamic points with current data, display this data within 10 seconds. The Graphic screens shall automatically refresh every 15 seconds.

J. Program Execution Frequency: The BACnet DDC controllers shall be able to completely execute PID loops at a frequency down to once per second, consistent with the mechanical process under control.

K. Response times:
   1. Object Scanning: Transmit change of values to requesting device within six seconds.
   2. Object Command: Reaction time of less than two seconds between command and device response.
   3. Alarm Response Time. An alarm event shall be annunciated at the workstation within 15 seconds.
   4. Restoration after a Loss of Panel Power: Upon a restoration of Power, the BMS controllers shall restart within 180 seconds. If the restart time is in excess of 180 seconds,

redundant controllers shall be provided

5. Configuration and Tuning Screens: Graphics Screens used for configuring, calibrating, or tuning points, control loops, and similar control logic shall automatically refresh within 6 seconds.

L. Reporting Accuracy of Control: Report values and maintain measured variables within tolerances as follows:

TABLE 1: Reporting Accuracy	
Measured Variable	Reported Accuracy
Space Temperature	plus, or minus 1 degree F
Ducted Air Temperature	plus, or minus 1 degree F
Outside Air Temperature	plus, or minus 2 degree F
Dew Point Temperature	plus, or minus 3 degree F
Water Temperature	plus, or minus 1 degree F
Water Flow	plus, or minus 2 percent full scale
Water Pressure	plus, or minus 2 percent full scale
Relative Humidity	plus, or minus 5 percent
Airflow (terminal)	plus, or minus 10 percent full scale
Airflow (measuring stations)	plus, or minus 5 percent full scale
Airflow (pressurized spaces)	plus, or minus 3 percent full scale
Air Pressure (ducts)	plus, or minus 0.1 in. w.c.
Air Pressure (space)	plus, or minus 0.01 in. w.c.
Electrical (A, V, W, Power Factor)	plus, or minus 1 percent of reading
Carbon Monoxide (CO)	plus, or minus 5 percent of reading
Carbon Dioxide (CO2)	plus, or minus 50 ppm
Electrical Monitoring	plus, or minus 5 percent of reading

M. Control Stability and Accuracy of measured variables within tolerances as follows:

TABLE 2: Control Stability and Accuracy		
Medium	Control Accuracy	Range of Medium
Air Pressure	plus, or minus 0.2 inches w.c. plus, or minus 0.01 inches w.c.	0 to 6 inches w.c. plus, or minus 0.1 inches w.c.
Airflow	plus, or minus 10 percent full scale	
Space Temperature	plus, or minus 2.0 degrees F	
Duct Temperature	plus, or minus 3 degrees F	
Humidity	plus, or minus 5 percent RH	
Fluid Pressure	plus, or minus 1.5 psi plus, or minus 1.0 inches w.c.	1 to 150 psi 0 to 50 inches w.c.

5.06 SUBMITTALS

A. Submission: Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved and reviewed by the Architect and Engineer (A-E) for contract compliance. Any deviations from these specifications or the work indicated on the drawings shall be clearly identified in the Submittals.

1. Contractor Qualification Submittal

2. Building Management System Software Submittals
3. Building Management System Hardware Submittals
4. Graphics Submittal
5. Operation & Maintenance Manual Submittal

B. Submission Period: The BMS contractor (BMSC) shall submit a list of projected dates of required submittals within 30 days of contract award.

C. Submittal Quantity: The BMS contractor (BMSC) shall submit eight (8) copies of each submittal type submitted in both hard and soft copy, for review prior to ordering or fabrication of the equipment.

D. Submittal Review Period: Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BMS design work.

E. Correction – Resubmission: The BMS Contractor (BMSC) shall correct any errors or omissions noted in the first A-E review, and provide a resubmission for approval, showing corrections prior to installation. Any further subsequent resubmissions for errors or corrections previously noted shall be at the expense of the BMS Contractor (BMSC) (BMSC).

F. Submittal Approval: Submittals shall be approved before any equipment is installed.

G. Contractor Qualification Submittal: Submit documentation of BMS Manufacturers and BMS contractor's qualifications, including those indicated in this Section's "Quality Assurance" if so, requested by the A-E.

H. Action Submittals: Certification of Contractor Qualifications: Submit documentation of contractor qualifications, including those indicated in paragraph 1.9 "Quality Assurance" if requested by the A-E.

I. Deviations: Any deviations from these specifications or the work indicated on the drawings shall be clearly identified in the Submittals.

J. Shop Drawings, Product Data, and Samples: The BMS contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award. Provide six copies of shop drawings and other submittals on hardware, software, and equipment to be installed or furnished. Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BMS work. Begin no work until submittals have been approved for conformity with design intent.
   1. Submittals shall be in defined packages.
   2. Provide drawings as AutoCAD compatible files on optical disk (file format: .dwg, .dxf, .vsd, or comparable) or hard copies on 11" x 17" prints of each drawing.
   3. Each package shall be complete and shall only reference itself and previously submitted packages.
   4. The packages shall be as approved/reviewed by the Architect and Engineer for Contract compliance.
   5. Equipment and systems requiring approval of local authorities must comply with such regulations and be approved.
   6. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means.
   7. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements.
   8. Filing shall be at the expense of the BMS Contractor where filing is necessary.
   9. Provide a copy of all related correspondence and permits to the Owner.
   10. Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
   11. The BMS Contractor shall correct any errors or omissions noted in the first review.

12. Clearly reference covered specification and drawing on each submittal.
13. At a minimum, submit the following:
    a. BMS network architecture diagrams: Riser diagrams showing network switch locations, network topology including control network layout, communication protocol, and wire types. Showing including all nodes and interconnections. Schematic diagrams of all control, communication, and power wiring for central system installation. Show interface wiring to control system.
    b. Sequence of Operation: Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system.
    c. Systems schematics: Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic use the same name.
    d. BMS Legend: Provide a list of BMS point naming convention. Indicate the format, structure, and standards of typical point names. The naming convention shall follow the “A3.FLR#.EQUIPx.POINTx” format.
        1) A3 = Building A3
        2) FLR# = Floor of building
        3) EQUIP = 6-10 character equipment tag per the schedules and numbered per the plans. Ex. AHU01.SAT = Air Handler 1 Supply Air Temperature.
        4) POINT = 3-5 character standard nomenclature for each point type (i.e. SAT = Supply Air Temperature)
        5) Provide character capability for VAV boxes to be named by Floor, Air Handling Unit Served, Room Number/Name or VAV box tag, unbundled point description such as Room Temp such that a VAV box on the 3rd floor served by AHU-01 = “FLR3.AHU04.VAV.C313:Room Temp”
        6) Provide a list of point names for typical equipment and functions with specific examples. Point names to be coordinated with owner and engineer.
    e. Point Schedules: Points schedule for each point in the ATC, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address. Point list for each system controller including both inputs and outputs (I/O), point numbers, controlled device associated with each I/O point, and location of I/O device.
    f. Interface Graphics: Samples of Graphic Display screen types and associated menus.
    g. Bill of Materials: Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used. Manufacturer’s description and technical data such as product specifications for items listed below and for relevant items furnished under this contract not listed below. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.
    h. Product data sheets: Data sheets or marked catalog pages including part number, photo and description for all products including software. Manufacturer’s description and technical data, such as product specification sheets, installation and maintenance instructions for items listed below and for relevant items not listed below:
        1) Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
        2) Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each

unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.

3) Product description with complete technical data, performance curves, and product specification sheets.
4) Installation, operation, and maintenance instructions including factors effecting performance.

i. Panel Schedule:
j. Control Damper Schedule:
k. Control Valve Schedules:
l. Room Schedule:
m. Interface Schedule:

K. Multiple Submissions: If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission. Clearly identify each submittal requirement indicated and in which submission the information shall be provided. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

L. Building Management System Software Submittals:
1. Software submittals shall contain narrative descriptions of program listings and a complete description of the graphics, reports, alarms, and configuration to be furnished with the workstation software.`
2. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, and DDC controller.
3. Description and technical data of all software provided and cross-referenced to products in which software shall be installed.
4. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
5. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
6. Listing and description of each engineering equation used with reference source.
7. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
8. Description of operator interface to alphanumeric and graphic programming.
9. Description of each network communication protocol.
10. Description of system database, including all data included in database, database capacity and limitations to expand database.
11. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughout.
12. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
13. BACnet System: The BMS Contractor shall install an “open protocol” HVAC Control systems that are compliant with present BACnet standards ASHRAE 135. BIBB’s and PIC statements shall be provided for each controller and must comply with the specified requirements, below. The Automatic Temperature Controls Contractor must provide documentation that its systems can communicate with multiple manufacturers over a MS/TP (master slave token passing) network and that future system extensions can be

competitively bid among a multitude of Contractors & Manufacturers whose operating protocol is also Based on the BACnet standard. BMS Contractor who represent product lines, which utilize a proprietary operating system, networks, or which cannot be extended by third party DDC System manufacturers, shall not be acceptable. (i.e. BACnet over ARCnet 156K). BMS manufacturers who utilize drivers, RS 232 communication ports or field server type interface devices to communicate with a BACnet system shall not be acceptable. As part of submittal package, provide sample PIC (product information conformance) statement for each DDC Controller indicating controller BTL conformity to ASHRAE BACnet standard.

M. Graphics Submittal: Provide graphical samples of standard and custom 3 dimensional, high Definition color Web Based graphic screens for each Web screen, provide a conceptual layout of the equipment along with monitoring and control parameters if so, requested by the A-E.
   1. Floor plans of the building(s).
   2. All mechanical system(s)

N. BMS Hardware Submittal: Shop Drawings shall include and consist of a complete list of equipment and materials, including manufacturers' catalog data sheets and installation instructions. Submit in printed and electronic format.
   1. Examples of written Unit Controller Checkout Sheets and Performance Verification Procedures for applications similar in scope shall be included for approval.
   2. Shop Drawings shall include the following requirements:
      a. Prepare an index sheet of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
      b. Prepare all shop drawings in the latest version of AutoCAD Software. The BMS contractor shall furnish an electronic copy with the submittal.
      c. The Building Management System Riser Diagrams shall depict the locations of all controllers and workstations, with associated network wiring.
      d. System Schematics of each mechanical system shall show all connected input/output control points, controllers, power supplies, system diagram, end device details, termination points and wire and type required from control panel to end device with reference to their associated controller.
         1) Typical drawings shall be allowed where appropriate.
      e. Shop drawings shall also contain complete wiring and schematic diagrams, sequences of operation, control system bus layout and any other details required to demonstrate that the system has been coordinated and shall properly function as a system.
      f. Shop drawings shall Specific Terminal identification for all control wiring shall be shown on the shop drawings (i.e. point to point diagram).
   3. Product Data: Manufacturer's data sheets on each product to be used. Data shall contain manufacturer's data on all hardware and software products required by the specification including:
      a. NICs for each BMS controller
      b. PICs for each BACnet controller
      c. LonTalk data sheet for each LON controller
      d. Preparation instructions and recommendations.
      e. Storage and handling requirements and recommendations.
      f. Installation methods.
      g. Product Certificates: Compliance with Article, Quality Assurance.
   4. Automatic Control Valve Schedules:
      a. Indicate control valve size

b. Indicate flow pattern
c. Indicate control valve connections and ratings
d. Indicate control flow rate
e. Indicate control valve pressure drop
f. Indicate control valve CV rating
g. Indicate control body material
h. Indicate control valve temperature and pressure rating
i. Indicate control valve location
j. Indicate control valve tagging
k. Indicate Leakage flow at maximum system pressure differential.
l. Indicate Torque required at worst case condition for sizing actuator.
m. Indicate actuator selection indicating torque provided.
n. Indicate Maximum close-off pressure.
o. Indicate actuator signal to control valve (on, close or modulate).
p. Indicate actuator position on loss of power.
q. Indicate actuator position on loss of control signal.
r. Indicate control valve actuator power requirements

5. Automatic Control Damper Schedules:
   a. Indicate damper dimensions (width depth, height)
   b. Indicate damper airflow
   c. Indicate damper blade width
   d. Indicate damper blade type
   e. Indicate damper frame, blade, and component materials
   f. Indicate pressure drop across the damper
   g. Indicate maximum close-off pressure
   h. Indicate damper leakage rate
   i. Indicate damper seals
   j. Torque required at worst case condition for sizing actuator.
   k. Indicate actuator selection indicating torque provided.
   l. Indicate actuator signal to control damper (on, close or modulate).
   m. Indicate actuator position on loss of power.
   n. Indicate actuator position on loss of control signal.
   o. Indicate damper manufacturer
   p. Indicate damper model number
   q. Indicate damper location.
6. Airflow Station Schedules:
   a. Indicate manufacturer
   b. Indicate model number
   c. Indicate device location.
   d. Indicate size
   e. Indicate design airflow rate
   f. Indicate station airflow range
   g. Indicate station airflow accuracy
   h. Indicate pressure drop
7. Interface Schedule: Details of all ATC interfaces and connections to the work of other trades. Master Integration Plan shall include:
   a. Network communications Topology between interfaced systems
   b. Planned Network Protocol
   c. Alarmed Points

d. Point Database
e. Sequence of Operations

8. Operator Workstation Schedules: Display data, CPU, Processer speed, HD etc.
9. Building Management System Schedules: I/O and Parameter Point's List.
10. Equipment and specific control systems which require approval of the local authorities having jurisdiction, which must comply with such regulations shall be approved by such prior to installation. Where filing is necessary, the expense shall be borne by the BMS Contractor.
11. Provide a copy of all related correspondence and permits/approvals to the Owner and A-E.
12. The BMS Contractor shall correct any errors or omissions noted in the first A-E review, and provide a resubmission for approval, showing corrections prior to installation. Any further subsequent resubmissions for errors or corrections previously noted shall be at the expense of the BMS contractor.

O. As Built Drawings: All drawings shall be reviewed after the final system checkout and updated or corrected to provide 'as-built' drawings to show exact installation. All shop drawings shall be acknowledged in writing by the owner before installation is started and again after the final checkout of the system. The BMS system shall not be considered complete until the 'as-built' drawings have received their final approval.

P. Operation and Maintenance (O&M) Manual Submittal: Upon completion of the work of this Section, six (6) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative. The Operation and Maintenance Manual electronic media shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents. This shall include the following categories:

1. Names, address and 24 hour telephone numbers of Contractors installing equipment, and the control systems and service representative of each.
2. The Workstation User's Manual shall contain Step by step procedures for each operator function, including:
   a. launching a web browser from a networked PC and login
   b. Web Browser screen menus and their functions
   c. Creating, modifying, or deleting schedules
   d. Uploading and downloading software to the field hardware
   e. Creating historical trends, collecting trend data, and generating trend graphs
   f. Enabling and assigning alarms and messages to reporting actions/groups
   g. Report generation and 'third party software'
   h. Backing up software and data files
3. The Project Engineering Manual for the project shall contain:
   a. System architecture overview and networking configuration
   b. Hardware cut-sheets and product descriptions
4. The contractor shall deliver 8 sets of 'as-built' drawings. All drawings shall be reviewed after the final system checkout and updated to provide 'as-built' drawings. The system shall not be considered complete until the 'as-built' drawings have received their final approval.
5. Installation, mounting and connection details for all field hardware and accessories
6. Commissioning, setup, and backup procedures for all control modules/accessories, BMS server software, and database.
7. Listing of basic terminology, alarms/messages, error messages and frequently used commands or shortcuts.

8. System Software Documentation shall contain:
    a. The contractor shall provide all Graphical Language Programs, detailing their application to specific HVAC equipment, together library detailing the function.
    b. Graphical relationship of the projects mechanical equipment hierarchy.
    c. All alarm messages for equipment and operator action required.
    d. Any revisions made because of the submittal process, during the installation, start-up, or acceptance portion of the project, shall be accurately reflected in the "as-builts".
        1) Software Operating manuals.
        2) Control Device address lists
        3) Color Printout of software applications
        4) Color Printout of graphic screens.
        5) All Software licenses.
9. System Maintenance Requirements: Maintenance instructions and lists of spare parts for each type of control device. Interconnection wiring diagrams with identified system components and devices. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances. Calibration records and list of set points. Licenses, Guarantee, and Warrantee documents for all equipment and systems. Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.
10. Testing and Commissioning Reports and Checklists
11. Notice of Completion: When the system performance is deemed satisfactory, the system parts shall be accepted for beneficial use and placed under warranty. At this time, the consultant shall issue a “notice of completion” and the warranty period shall start.

Q. Coordination Drawings: Plan drawings and corresponding product installation details showing the locations of devices, as coordinated from input from installers of the items involved:
    1. Installation location shown in relationship to room, duct, pipe, and equipment.
    2. Structural members to which products shall be attached.
    3. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
    4. Size and location of wall access panels for products installed behind walls and requiring access.
    5. Reflected ceiling plans and other details on which the following items are shown and coordinated with each other, using input from installers of the items involved:
    6. Size and location of access panels for products installed above inaccessible ceiling assemblies and requiring access.
    7. Items penetrating finished ceiling including the Access panels, Motion sensors, Pressure sensors, Temperature sensors and other DDC control system instruments.

R. Product Certificates: Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with LonWorks.

S. Product and Preconstruction Testing Reports: For each product that requires testing to be performed by manufacturer and witnessed by a qualified testing agency.

T. Source and Field quality-control reports.

U. Sample Warranty: For manufacturer's warranty.

V. Maintenance Material Submittal: Furnish to the owner upon completion of the project the manufacturer's recommended parts list, for product operation during one-year period following warranty period for ready stock devices that match products installed. The device shall be delivered with protective covering for storage and identified with labels describing contents.

1. Furnish to the Owner the quantity indicated of product(s) types of the following:
    a. (1) Application-Specific Controller.
    b. (1) Room Carbon Dioxide Sensor.
    c. (1) Room Relative Humidity Sensor.
    d. (1) Room Pressure Sensor.
    e. (1) Room Temperature Sensor.
    f. (1) General-Purpose Relay
    g. (1) Current-Sensing Relay.
    h. (1) 75VA Control Transformer: One.

5.07 QUALITY ASSURANCE

A. Single Source Responsibility of System performance: A single Building Management System Contractor (BMSC) shall be responsible for the complete installation and proper operation of the control system. This contractor shall exclusively be in the regular and customary business of designing, installing, and servicing computerized Building Management Systems, similar in size and complexity to the BMS specified. Additionally, this contractor shall be a manufacturer local branch of the BMS DDC components or shall have been the manufacturers Authorized representative for the DDC manufacturer for at least five 5 years. The device and electrical installation may be sub-contracted to a single qualified controls installation sub-contractor.

B. Building Management System - Factory Authorized Representative: The Building Management System contractor (BMSC) shall be a fully certified, factory authorized & licensed representative for the Building Management Systems (BMS) manufacturer. The BMSC shall have attained the highest recognition of certification of quality installations available (ACI-Direct) and shall have maintained this rating as an authorized representative for the BMS DDC components for a minimum of 5 years. The BMS Contractor shall have a minimum of (20) directly employed (subcontracted staff shall not be acceptable) full time technicians which have certification Honeywell (WEBs-N4) for the Building Management System specified.

C. Complexity and Project Magnitude: The BMS Contractor shall be responsible for the complete installation and proper operation of the control system. The BMS Contractor shall exclusively be in the regular and customary business of design, installation, and service of computerized building management systems similar in size and complexity to the system specified. As evidence and assurance of the BMS Contractor's ability to support the installation, the BMS Contractor must have successfully completed at least ten (10) total projects utilizing the approved controls, at least five (5) times the value of this contract in each of the preceding five (5) years.

D. Experience & Longevity: The BMS Contractor shall be representative for an approved BMS manufacturer for at least three (3) years and shall have a proven track record of successful installations and integrations with the approved BMS manufacturer's control equipment proposed for the project. As evidence and assurance of the contractor's ability for system support, post-completion with service and parts, the contractor shall have been a manufacturer licensed provider for minimum of ten (10) years and have successfully completed a minimum of ten (10) projects in each of the preceding five (5) years of five (5) times the value of this contract A list of projects of comparable scope, detailing the Building Managements System communications integrations involved in this project shall be provided to the A-E.

E. Control System Expertise: The BMS Contractor's primary business shall be regularly engage in the engineering, programming, installation, and service of total integrated Building Management Systems. The BMS Contractors business shall dedicated solely to that of "Automation Temperature Controls & Building Management Systems" (C043 & C098). Contractors whose discipline do not concentrate to these categories shall not be acceptable.

F. Ready Stock Spare and Repair Parts Availability: The BMS Contractor shall maintain and have an independently verifiable on hand inventory of ready stock and repair spare parts inventory, Direct Digital Controllers, and electronic service parts, including all testing and diagnostic equipment necessary to support this work. This inventory value must have a worth of at least $100,000 per year over each of the preceding five years.

G. Specific Project Requirements: In the submittal, the contractor shall indicate Full Conformance and Compliance to the following requirements:
   1. No Proprietary communications protocol at any level.
   2. The database must be a standard Niagara 4 Open Database.
   3. All systems must communicate over the Wide Area Network (WAN).
   4. All system graphics shall utilize Niagara 4 Web-based 3-D structure.
   5. All new BACnet DDC controllers must communicate over the existing Johnson Facility Explorer (FX) Communication Network and use the Niagara N4 Framework for the owner interface into the BMS.
   6. All new BACnet DDC controllers must communicate over the existing Honeywell (WEBs) Communication Network and use the Niagara N4 Framework for the owner interface into the BMS.

H. Acceptable Building Management System Manufacturers: Building Management Systems utilizing a restricted or single source of direct digital control materials or proprietary controls, including HVAC Equipment controls, wholesale distributors or contractors which do not meet Building Management System's (BMS) factory ACI-DIRECT certification at the time of bid, shall not be acceptable.

I. Building Management System Manufacturer: The Building Management Systems (BMS) System architecture shall consist of the products of a manufacturer regularly engaged in the production of DDC Control Systems and shall be the manufacturer's latest standard of design at the time of bid. All controls, other than relays, transformers and panels shall be the product of the same manufacturer. The Building Management System shall be as manufactured and supported by:
   1. Honeywell Controls (WEBs-N4) as provided by an ACI-DIRECT. Regional ACI-Direct AME, Inc. (973) 884-4100. The Honeywell EBI product line shall not be acceptable.
   2. Engineer approved equal.
   3. Building Management System manufacturers shall not be acceptable by Sole Source or HVAC Equipment Unit manufacturer control systems; Building Management Systems utilizing proprietary controls are not acceptable; Dealers and Wholesalers of Manufacturers submitted outside of the guidelines for approval for equivalence or Unauthorized contractors (BMSC)s buying controls from a wholesale distributors,. Bids by wholesalers, service companies or any other firm that cannot document a (minimum) three (3) years direct Authorized relationship with the Building Management System's (BMS) manufacturer shall not be acceptable.
   4. Engineer Approved Equal via issued Addendum Only: Any request for substitution of an unspecified Building Management System shall only be permitted up to and at time of the bid date. No further requests shall be considered or permitted after the bid date. Allow ten (10) working days after the bid date for review of documentation. The requested BMS manufacturer shall meet or exceed all of the specification requirements of the Basis of Design manufacturer in all aspects including this Sections "Quality Assurance" requirements. The requested Building Management System designs and controllers are required to be Niagara 4 infrastructure. Cohabitation or use of any additional software shall not be allowed. The M-E-P shall review the submitted documents as detailed above for compliance with specified performance, materials, articles and equipment in meeting the intent of the specification. If approved, this review shall not alleviate the contractor

from meeting all aspects of the specifications; however, the Engineer or Owner is not required to permit substitution pursuant to the case of Whitten Corporation vs. Paddock, Incorporated, United States District Court, Massachusetts, April 12, 1974, affirmed by the Federal First Circuit Court, December 14, 1974, and the United States Supreme Court, 1988. Failure to the submit the information outlined above for review at the time of bid shall result in rejection of contractor's request for substitution after the bid date.

5.08 PROJECT MANAGEMENT

A. Pre-Installation Coordination Meetings: A meeting shall convene a minimum two weeks prior to starting work of this section.

B. Project Management: The BMS contractor shall designate an experienced BMS Project Manager who shall manage the BMS installation and commissioning. The designated BMS Project Manager shall be empowered to make technical, scheduling and field related decisions on behalf of the BMS Contractor. As a minimum, the BMS Project Manager shall manage the scheduling of the work to ensure that adequate materials, labor, and other resources are available as needed; Manage the financial aspects of the BMS Contract; Coordinate as necessary with other trades; Be responsible for the work and actions of the BMS workforce on site.

C. Permitting: Equipment and BMS systems requiring approval of local authorities shall comply with such regulations shall be approved by such prior to installation. Where filing is necessary, unless stated otherwise in the project documentations, the expense shall be by the BMS Contractor (BMSC) (BMSC). Provide a copy of all related correspondence and permits/approvals to the Owner.

D. Workplace Safety Program: The BMS Contractor shall provide a safety program in compliance with the Contract Documents. The BMS Contractor shall have a corporately certified comprehensive Safety Certification Manual and a designated Safety Supervisor for the Project. The BMS Contractor and its employees and sub trades comply with federal, state, and local safety regulations. The BMS Contractor shall ensure that all sub-contractors and employees have written safety programs in place that covers their scope of work, and that their employees receive the training required by the OSHA having jurisdiction for at least each topic listed in the Safety Certification Manual. The BMS Contractor shall sign and date a safety certification form prior to any work being performed, stating that the BMS Contractors' and subcontractors company are in full compliance with the Project safety requirements.

5.09 MATERIAL DELIVERY, HANDLING, AND STORAGE

A. Delivery and Handling: The integrity of shipping cartons for each piece of equipment and control device through shipping, storage and handling shall be maintained to prevent equipment damage.

B. Hazardous Material Handling: The BMS Contractor's Safety program shall include written policies for the handling, storage, and management of all hazardous materials to be used during the course of the control work in compliance with the requirements at the Project site. The BMS Contractor's employees and sub-contractor's staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.

C. Factory Mounted Components: Control devices when specified, or when indicated to be factory mounted, shall be arranged for shipping to the equipment manufacturer's factory.

D. Storage: Any onsite equipment and materials shall be stored inside and protected from weather.

5.10 WARRANTY - MATERIAL AND LABOR

A. Warranty Period: Labor and materials for control systems shall be warranted for a period as specified under Warranty in Section 00 72 00, General Conditions.

B. Provide a one year labor and material warranty on the BMS. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor. Maintain an adequate supply of repair devices within 50 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BMS Contractor's normal business hours.

C. Start of Warranty Date: After the Engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, the Engineer shall certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. The contractor shall provide the owner in writing the Date of acceptance and the beginning of the warranty period.

D. Software Warranty: The contractor shall provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve identified software deficiencies at no charge during warranty period. Do not install updates or upgrades without Owner's written authorization.

E. Warranty - Remote Support Service: The BMS Contractor shall remotely connect to monitor and control the facility's Building Management System during the warranty period. This remote connection to the facility shall be within two hours of the time that the problem is reported. This coverage shall include normal or after business hours, weekends, and holidays. If the problem cannot be resolved with remote support services, the BMS Contractor shall dispatch the qualified personnel to the project site to resolve the problem within 24 hours.

5.11 OWNERSHIP OF PROJECT MATERIAL

A. Programming and Software: The Owner shall have full ownership and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS. Project specific software and documentation shall become Owner's property.

B. Owners Access Rights and Licensure: The Owner shall receive all Administrator level login and passwords for engineering toolset at first training session. The Owner shall have full licensing and full access rights for all network management, operating system server, engineering and processes generation software required for the ongoing maintenance and operation of the BMS. All software will be licensed to the owner with full password capability and access. Under no circumstances will any part of the BMS software be licensed or controlled by the BMS Contractor (BMSC). The entire system including original software discs will be turned over to the owner.

5.12 APPLICABLE CODES REQUIREMENTS

A. The following issues of the publications referred to thereafter by basic designations only, form a part of this specification. Inclusion in this listing is intended to call particular attention to the subject matter covered:
   1. International Energy Code (IEC)
   2. International Mechanical Code (IMC)
   3. ASHRAE Standard 90.1
   4. ASHRAE Standard 62.1
   5. FIPS: Federal Information Processing Standards Publications: FIPS PUB 15: Subsets of the Standard Codes for Information Exchange.
   6. ANSI: American National Standards Institute Publications:
      a. -1977 Power Piping (including addenda) B31.1b (1971); B31.1c (1972); and B31.1d (1972).
      b. C2-1981 National Electrical Safety Code.

c. C12-1975 Electricity Metering.
d. 3 1968 Requirements for Instrument Transformers.

7. EIA: Electronic Association Standards: RS-232C/RS-485 Interface between data terminal equipment and data communication equipment employing serial binary data exchange. 1.
8. AWS: American Welding Society Publication: B30-77 Welding Procedures and Performance Qualification.
9. NFPA: National Fire Protection Association Publication: 70 and National Electrical Code.
10. NEMA: National Electrical Manufacturer's Association (NEMA): ED 20-75, Watt-hour Meters.

PART 1 PRODUCTS

6.01 BUILDING MANAGEMENT SYSTEM MANUFACTURERS

A. Acceptable Manufacturers:
   1. Honeywell – WEBs-N4 – Certified as ACI-DIRECT AME, Inc.; Tel: 973-884-4100; Email: info@ame-inc.com. The use of the Honeywell-EBI product line shall not be acceptable.
   2. Or Engineer Approved Equal (via issued addendum).

B. Substitutions: Not permitted after bid date.

C. Non-acceptable systems include:
   1. Single sourced or equipment manufacturer provided control systems i.e. York, Carrier, Daikin, Trane, etc...
   2. Any of the listed control system manufacturers listed in Section 2.1.A which utilize proprietary protocols or controls, Non-Open Source or Not-Open Systems.
   3. Contractor requests for equivalent Manufacturer review received after the bid date or have not received the Engineers written approval as detailed in Part 1 of this section.

6.02 SYSTEM DESCRIPTION

A. Overview: The Building Management System specified in this document shall be Web-based, utilizing the Open Source – Open System Niagara 4 Platform.

B. Specific Project Requirements:
   1. All control products provided for this project shall comprise an industry standard open protocol internetwork. Communication involving control components (i.e. all types of controllers and operator interfaces) shall conform to ANSI/ASHRAE 135 BACnet standard. Using protocols on any part of the BMS network that is proprietary to one company or distributed by one company are prohibited.
   2. The primary BMS network level shall be BACnet/IP over Ethernet. It shall network all primary DDC controllers (B-BC, B-AAC), the BMS server, operator workstations (B-AWS), routers and switches.
   3. All products must be Open Source.
   4. All No Proprietary communications protocol at any level.
   5. All hot water valves shall fail open to the coil.
   6. All control valve actuators shall have a mechanism for local override at the unit.
   7. All modulating control valves shall be 0-10VDC or 4-20mA.
   8. All System Graphics, including Floor plans shall be depicted in a 3-D aspect.
   9. All Graphical Floor plans shall be thermographic, changing color as deviation from setpoint.
   10. All Outputs on Building Controllers (B-BC) and Advance Application Controllers (B-AAC) shall have onboard override switches. These switches shall be monitored.
   11. High Priority alarms, as defined by the owner, shall provide an escalation text or email.

C. Environmental Conditions: Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed

location. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:

1. Outdoors - Protected: Type 12.
2. Outdoors - Unprotected: Type 4.
3. Indoors - Heated with Filtered Ventilation: Type 1.
4. Indoors - Heated with Non-Filtered Ventilation: Type 12.
5. Indoors - Heated and Air Conditioned: Type 1.
6. Mechanical Rooms Chiller and Boiler Rooms: Type 12.
7. Mechanical Rooms Air-Moving Equipment Rooms: Type 1.
8. Localized Areas Exposed to Washdown: Type 4.
9. Within Duct Systems Not Exposed to Possible Condensation: Type 12.
10. Within Duct Systems Exposed to Possible Condensation: Type 4.
11. Hazardous Locations: Explosion-proof rating for condition.

D. DDC System Reliability: Design, install and configure DDC controllers, gateways, routers to yield a MTBF of at least 20,000 hours, based on a confidence level of at least 90 %. MTBF value shall include any failure for any reason to any part of products indicated. If required to comply with MTBF indicated, include DDC system and product redundancy to maintain DCC system, and associated systems and equipment that are being controlled, operational and under automatic control. Critical systems and equipment that require a higher degree of DDC system redundancy than MTBF indicated shall be indicated on Drawings.

E. Electric Power Quality: Protect primary network and critical system DDC controllers which are connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41. Do not use fuses for surge protection.

F. Power Conditioning: Protect primary network and critical system DDC controllers which are connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner. At 85 % load, output voltage shall not deviate by more than plus or minus 1 % of nominal when input voltage fluctuates between minus 20 % to plus 10 % of nominal. During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 % of nominal. Accomplish full correction of load switching disturbances within five cycles, and 95 % correction within two cycles of onset of disturbance. Total harmonic distortion shall not exceed 3-1/2 % at full load.

G. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.

H. Backup Power Source: HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.

I. Uninterruptable Power Supplies: Critical DDC system instruments and actuators powered by UPS units shall include the Input and Output Devices, sensors, Control Dampers Actuators, and Control Valve Actuators associated with the following systems controlled by the DDC system. DDC system products powered by UPS units shall include the following:

1. Network Controllers
2. Critical System DDC controllers.
3. BMS Servers.

4. Graphical Operator Workstations.
5. Alarm Printers.
6. System Gateways.

J. Continuity of Operation after Electric Power Interruption: Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

6.03 BUILDING MANAGEMENT SYSTEM NETWORK ARCHITECTURE

A. General: The Building Management System (BMS) shall be comprised of a network of interoperable, standalone digital controllers (B-BC, B-AAC, B-ASC), a network area controller (SNC), graphics and programming and other control devices for a complete system as specified herein. The installed system shall provide secure password access to all features, functions and data contained in the overall BMS.
1. The Building Management System (BMS) is based in the Honeywell (WEBs-N4) BACnet architecture.
2. The BMS shall integrate a wide variety of third party devices and applications.
3. The BMS shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.

B. Network Architecture: The system shall utilize an open architecture consisting of no more than three (3) network tiers capable of the following:
1. Utilizing TCP/IP communications operating at a minimum speed of 100 Mb/sec.
2. ANSI/ASHRAE BACnet Standard 135 protocol shall be sole and native protocol used throughout entire DDC system.
3. If used, gateways shall connect to the system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Operator Workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.
5. The networks shall utilize only copper and optical fiber communication media as appropriate and shall comply with applicable codes, ordinances, and regulations.
6. All necessary TCP/IP connections and Internet Services shall be provided by the owner.
7. The Level one TCP/IP LAN shall connect network controllers (SNC), Building Level Controllers (B-BC) and Operator workstations (B-AWS).
8. The Level two LAN shall connect programmable Application Specific Controllers (B-ASC) to other programmable application controllers, and to network controllers.
9. The Level three LAN shall connect application-specific controllers to programmable application controllers and/or network sensors.
10. The Building Management System shall not require use of gateways except to integrate third party HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
11. Portions of the Building Management System networks integration may use an Open implementation of network devices and technology complying with Modbus Application Protocol Specification V1.1b.

C. Communication Speed:
1. 100 Mbps.
2. 100 Mbps.
3. 76.8 kbps.

D. Dedicated Building Management System Network: The Building Management System shall consist of dedicated and separated networks that are not shared with other building systems and tenant data and communication networks. The Building Management system's architecture shall be modular and have inherent ability to expand to not less than two times system size indicated with no impact to performance indicated. The Building Management System architecture shall perform modifications without having to remove and replace existing network equipment.

E. Transparency: The number of LANs and associated communication shall be transparent to the Operator. All I/O points residing on any LAN shall be capable of global sharing between LANs.

F. Controller Independence: The system design shall eliminate dependence on any single device for alarm reporting and control execution. Each controller shall operate independently, performing its' own control, alarm management and historical data collection.

G. The Building Management System shall consist of the following:
   1. System Network Controllers(s)(SNC)
   2. Operator Workstations (OWS)
   3. Graphical User Interface(s)(GUI)
   4. Portable Operator's Terminal(s) (POT)
   5. Local Touch-Screen Display Device(s)(LCD)
   6. Building Level Controllers (B-BC)
   7. Advance Application Controller (B-AAC)
   8. Application Specific Controllers (B-ASC)
   9. VAV Application Specific Controllers (B-ASC)
   10. Input/Output Module(s)(IOM)
   11. Network communications equipment
   12. Other components required for a complete and working BMS

H. The Building Management System shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers, and operator devices.

I. The Building Management System's architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

J. Equipment System Integration by Physical Hardwired Interface: Analog and digital signal values shall be passed from one system to another via hardwired connections. There shall be one separate physical point on each system for each point to be integrated between the systems.

K. Equipment System Integration by Open Communications Protocol Integration: The connection of any integrated equipment shall be BACnet MS/TP or BACnet TCP/IP. BACnet over ARCnet 156K is prohibited and shall not be acceptable. The neutral protocol used between systems shall be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135. The Unit manufacturer shall provide a complete Protocol Implementation Conformance Statement (PICS) for all BACnet system devices. The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided. The BMS contractor shall integrate real time data from building systems by other trades and databases originating from other trades as specified and required by the Contract Documents. The systems shall include necessary hardware, equipment , and software to integrate via an Open communications protocol between the various equipment systems supplied by other construction trades. The other trade contractors which are supplying associated systems and equipment shall, at their expense, provide their necessary hardware, software and fully

cooperate with the BMS contractor in a timely manner to ensure a complete and functional integration.

L. Equipment System Integration by Proprietary Communications Integration Protocol: The BMS shall include hardware and software to allow bi-directional data communications to the Integrated equipment. The BMS shall provide a communications Integration to non-standard communication protocols, utilizing technology to span the proprietary protocol of legacy BMS systems. The communication Integration shall utilize vender specific software driver to communicate with the Integrated equipment. All data required by the application shall be mapped into the integration database and shall be transparent to the Operator. Data objects or I/O points from the Integrated controllers shall have real time interoperability with the BMS software: The BMS software shall provide for any Global Energy Management or Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.

6.04 OPEN, INTEGRATED, AND INTEROPERABLE.

A. Overview: The intent is to provide an Open Source - Open Building Management System (BMS) utilizing distributed web based direct digital controls which communicate over a BACnet communications network. The Building Management System's BACnet controllers, materials and components furnished shall be unrestricted and available for acquisition by the Owner through multiple independent sources and service providers. The contractor shall provide the sources and providers to the M-E-P, upon request.

B. Network Communications Protocol: Network communication protocol(s) used throughout entire DDC system shall be open and available to other companies for use in making future modifications to DDC system. The Honeywell WEBs-N4 DDC Controllers shall reside on the BACnet communications sub-network.

C. Hierarchical Network Topology: A hierarchical network topology is required to assure reasonable system response times and to manage the flow and sharing of data, without unduly burdening the owner's internal Intranet network. Building Management Systems that employ a "flat" single tiered architecture shall not be acceptable.
   1. Acceptable networks for connecting Operator workstations (B-AWS), Supervisory Network Controllers, Building Level Controls (B-BC), Advanced Application Controllers (B-AAC) include IP or IEEE 8802-3, Ethernet.
   2. Acceptable networks for connecting Application Specific Controllers (B-ASC) include IP, IEEE 8802-3, Ethernet, EIA-485A and CEA-709.1-C

D. Peer to Peer DDC controllers: All DDC controllers supplied under this contract shall be true "peer to peer" communicating devices. DDC controllers requiring "polling" by a host to pass data shall not be acceptable

E. Open Graphical Objects: The BMS Graphical programming software shall employ object oriented technology (OOT) for representation of all data and control devices within the system.

F. Open Database Connectivity: An Open Database Connectivity (ODBC) or Structured Query Language (SQL) server database is required for all data storage. The BMS system shall incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary interface, programs, or browser plugins. Any BMS system which provides or requires a proprietary database or user interface program shall not be acceptable.

6.05 EMBEDDED WEB-BASED SYSTEM GRAPHICS

A. Operator Workstation (OWS) and Thin Client Stations (TCS) Web Browser Interface shall have the current version of Microsoft Windows, Firefox, and Chrome browsers, and as well as non-Window operating systems. The OWS shall have a valid connection to the BMS Tier 1 network via an LAN &/or WAN ethernet network and shall have an Open System web-browser (i.e. Explorer/Firefox/Chrome) and shall not require installation of any custom software on the thin-

client or workstation.

B. Open Web-browser Graphical Interface: An Open web-browser shall interface with the embedded web-graphics via the BMS Tier 1 Ethernet and shall be accessed using a web browser over the Owner's intranet and/or remotely over the Internet. The BMS Contractor (BMSC) shall provide a web-based graphics designed using Open web technology standards. Web-browser Interface to the system embedded web-graphics shall be supported by Windows 7, 8.1, Server 12 operating system platforms, as a minimum.

C. Autonomous Web-Browser and Operating System: The embedded web-interface shall be browser and operating system independent. Specifically supporting HTML5 enabled browsers without requiring proprietary operator interfaces, applets, configuration programs or browser plug-ins installed on the thin-client workstation.

D. System Security - Secure Socket Layers (SSL): Communications between the web-browser and embedded BMS graphics shall offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL) through public domain Open protocols such as Hyper-Text Transfer Protocol (HTTP).

E. Web-Browser Features: The embedded graphics shall provide a completely interactive Operator interface and shall provide a HTML5 experience that supports the following features as a minimum:
   1. Trending.
   2. Scheduling.
   3. Electrical demand limiting.
   4. Duty Cycling.
   5. Downloading Memory to field devices.
   6. Real time 'live' Graphic Processes.
   7. Tree Navigation.
   8. Parameter change of properties.
   9. Set point adjustments.
   10. Alarm / event information.
   11. Configuration of operators.
   12. Execution of global commands.
   13. Add, delete, and modify graphics and displayed data.

F. Embedded Software Components: All software shall be the most current version. All software components shall be provided and installed as part of this project. Building Management System software components shall include:
   1. Web-Server Software
   2. Open Source Database
   3. Web Browser Graphical User Interface.
   4. Embedded System Configuration Utilities for future modifications
   5. Embedded Graphical Process Programming Tools.
   6. Embedded Direct Digital Control software.
   7. Embedded Application Software.

G. Software Maintenance: A five (5) Year Software Maintenance license shall be included. Labor to implement shall be additional.

6.06 BACNET ADVANCED OPERATOR WORKSTATION (B-AWS)

A. Overview: The Advanced Operator Workstation (B-AWS) shall provide the Operator comprehensive control and monitoring of the Building Management System via a standard Web Browser interface by using a collection of web pages. The Web pages shall be constructed to "feel" like a single application and provide a complete and intuitive control of the Building

Management System. The intent is to provide the operator(s) complete access to the BMS system via a web browser. The web browser shall be operating system agnostic, meaning it shall support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plugins. The web browser GUI shall provide a completely interactive user interface for navigation, and display of dynamic animated graphics, schedules, alarms/events, live graphic programs, active graphic setpoint controls, configuration menus, data archiving, reports and reporting actions and supports the following features as a minimum:

1. Trending.
2. Scheduling.
3. Electrical demand limiting.
4. Duty Cycling.
5. Downloading Memory to field devices.
6. Real time 'live' Graphic Programs.
7. Tree Navigation.
8. Parameter change of properties.
9. Set point adjustments.
10. Alarm / event information.
11. Configuration of operators.
12. Execution of global commands.
13. Add, delete, and modify graphics and displayed data.

B. Software Components: The system software shall be latest version as part of this project and shall include:
   1. Server Software and Database Software
   2. Embedded Web Graphics.
   3. Embedded System Configuration Utilities for future modifications
   4. Embedded Graphical Programming Tools.
   5. Embedded Direct Digital Control software.
   6. Embedded Application Software.
   7. A five (5) Year Software Maintenance license shall be included. Labor to implement shall be additional.

C. User Login: A Web link shall direct the web-browser to the Building Management System's domain name or IP address, Login web page. The Operator shall be required to enter their unique login name and strong password to gain access.

D. Navigation: Navigation within system shall be dependent on the Operator's assigned Role Based application control privileges. Navigation shall be accomplished by selecting the navigation tree which consists of expandable and collapsible tree control and/or by selecting dynamic links to other system graphics. The Navigation tree shall as a minimum provide the following views:
   1. A Geographic View which displays a logical geographic hierarchy of the system including cities, sites, buildings, building systems, floors, equipment, and objects.
   2. A Network View which displays a logical Network hierarchy of the BMS including B-BCs, B-ASCs, B-VAVs.
   3. A Group View which displays the Scheduled Groups and any Custom reports.
   4. A Configuration View which displays all the interface categories, including Operators, Schedule, Events, Reporting, and Roles

E. Action Pane: Web Graphics shall use a 3-D perspective graphics format suitable for display in a web browser, the system graphics shall include an overall site/building/campus views, building floor plans, equipment drawings, active graphic setpoint controls, web content and other valid HTML elements. The data on each graphic page shall automatically refresh.

1. Dashboards shall allow the Operator to interface with customizable data using drag and drop HTML5 elements. The elements shall include Web Charts, Gauges, and other custom developed widgets for use in a web browser. The Operator shall have ability to save custom dashboards.
2. Search feature shall provide the Operator with options for searching data based upon tags, associated equipment, real time data, properties, and trends.
3. Properties of the system shall include graphic controls, locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the Operator to depress an 'accept/cancel' button.
4. Schedules shall provide the Operator to create, modify/edit and view schedules based on the systems hierarchy.
5. Alarms shall provide the Operator alarm information geographically, acknowledge alarms, sort alarms by category, actions and verify reporting actions.
6. Charting shall provide the Operator a display of associated trend and historical data, modify colors, date range, axis, and scaling. The Operator shall have ability to create HTML charts through web browser without utilizing chart builder. The Operator shall be able to drag and drop data points, schedules, and apply status colors for analysis.
7. Logic - Live Graphical Language Programs shall displayed dynamically 'live', for each of the control algorithm, (micro-block programming) for the system selected in the navigation tree.
8. Other actions such as Print, Help, Command, and Logout shall be available via a drop down window.

F. Customized 3 Dimensional Color Graphics: Tools required to create Web Browser graphics shall be non-proprietary. The Web pages shall make extensive use of color to communicate information related to the system setpoints and controls parameters. Animated gifs or jpg, vector scalable, active set point graphic controls shall be used to enhance usability. The Web-page display shall be uniform in size and depth of color, a standardized graphically display shall be 1024 by 768 pixels, 24 bit True Color.

G. System Graphics Requirements (minimum): An area map or individual Building Overview graphic shall be provided which shall show locations of controlled buildings in relation to local landmarks. Detailed Floor Plans graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective set points. The colors shall be updated dynamically as a zone's actual comfort condition changes. Unique Mechanical Systems graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability.

H. Security Access: Access to the system shall require a Login Name and Strong Password. Access to different areas of the system shall be by the defined Operator Role and Access Control privileges.
1. Operator Roles shall reflect the expected interface Roles of Operators of the system. Each Operator Role shall comprise a set of privileges defined in terms of Viewing, Editing or Functions.
2. Operator View Privileges shall comprise Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
3. Operator Edit Privileges shall comprise Setpoint, Tuning and Logic, Manual Override, and Point Assignment Parameters.
4. Operator Function Privileges shall comprise Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print and Alarm/Event Maintenance.

5. Operator Geographic Assignment of Roles shall be assigned using a similar geographically expandable/collapsible navigation tree. I.e. it shall be possible to assign two HVAC Technicians with similar defined HVAC Roles, differing system geographical areas access.

I. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an Operator shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room or choose to apply a hierarchical schedule to the entire system, site, or floor area. I.e. Independence Day ' Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention would be required and every control module in the system with would be automatically downloaded with the ' Independence Day' Holiday. All schedules that affect the system /area / equipment shall be highlighted in the Navigation Tree and shown in a summary schedule table and graph.
   1. Schedules Types & Standards: Schedules shall comply with the BACnet LonWorks standards. (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
      a. Types of schedule shall be Normal, Holiday or Override.
      b. A specific date or a range of dates.
      c. Any combination of Month of Year, Week of Month, or Day of Week .
      d. Wildcard (i.e. allow combinations like second Tuesday of every month).
   2. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
   3. Schedule Groups: Operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site.
   4. Intelligent Scheduling: The system shall automatically turn on any supporting equipment needed to control the environment in an occupied space.
   5. Partial Day Exceptions: Events shall be able to accommodate a time range specified by the operator.
   6. Summary Schedule Graph: The schedule summary graph shall show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules.

J. Alarms (or Events): Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions shall have the following capabilities:
   1. An Alarm View which shall display the Alarms Category with a unique icon, the date/time of occurrence, current status, alarm report and a URL link to the associated graphic for the selected system, area, or equipment. The URL link shall indicate the system location, address, and other pertinent information. An Operator shall easily be able to sort events, edit event templates and categories, acknowledge, or force a return to normal in the Events View.
   2. An Alarm Categories which shall allow an Operator to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. A unique icon shall be associated with each alarm category.
   3. An Alarm Template which shall allow an Operator to define the type of alarm and its properties. The Alarm properties shall include a reference name, a verbose description, the severity of alarm, any acknowledgement requirements, and limits and out of range information.

4. An Alarm Area which shall allow an Operator to assign specific Alarm Categories to specific Alarm Reporting Actions.
5. An Alarm Time/Date Stamp which shall be generated by the controller's RTC Time/Date.
6. Alarm Configuration which shall allow an Operator to define the type of Alarm generated per object.
7. Alarm Summary Counter shall allow a view of Alarms in the Graphic Pane with a numeric counter, indicating how many Alarms are active, require acknowledgement and total number of Alarms in the Archival database.
8. Alarm Auto Deletion that are acknowledged and closed shall be auto deleted from the database and archived to a text file after an Operator defined period.

K. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the system. The system Operators shall be able to define the Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall inform the Operator of an Alarm by the following actions:
1. A hard-copy printing to a network printer.
2. An E-mail sent to one or more email accounts on a POP3 compatible server.
3. An alphanumeric paging services, where POP3 email servers support pagers.
4. An ASCII File write reporting action to append Operator defined alarm information to through a text file.
5. A write property value in a system network controller.
6. A Simple Network Management Protocol (SNMP) to an SNMP trap.
7. Run an external software program

L. Graphical Trends: Trends shall be enabled for all controller hard I/O points. Point Data shall be collected locally by the controller, the data shall be uploaded to the data archival server periodically. The Operator shall have the ability to view 'Live' and historical trend data. The Trend data shall be comprised of analog, digital or calculated points, allowing for configuration and displaying multiple trends simultaneously trends through a web-browser. Each point shall have the ability to be collected at different trend intervals. The Trend resolution shall automatically scale the X-axis and Y-axis when multiple trend points are selected which have different trend intervals or ranges. When Trend data collection is viewed 'Live', the Trend graphic shall update dynamically. The Trend Graphic shall allow the Operator to zoom in on a particular section of a trend and scroll through' historical archived data graphically. The data value shall be imposed on the Trend graphic when any the point sample is selected. The Operator shall through the use of standard keystrokes (CTRL+C, CTRL+V), be able to copy the data.

6.07 GRAPHICAL PROGRAMMING LANGUAGE (GPL)

A. Overview: The Graphic Programming Language (GPL) for all DDC control algorithms shall be resident in all of the BMS controller modules. Any Building Management System that does not use a drag and drop method of graphical icon programming shall not be acceptable.

B. GPL Program Design: All BMS systems shall use a GPL method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain the programming necessary to execute the function of the device it represents. Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic

"wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.

C. Graphic Sequence: The clarity of the graphic sequence shall be such that the operator has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming shall be self-documenting and provide the operator with an understandable and exact representation of each sequence of operation.

D. Graphical Programming Language (GPL) capabilities: The following is a minimum definition of the capabilities of the GPL software:
   1. Function Block (FB): A collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
   2. Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
   3. Microblocks: A software device that are represented graphically and may be connected together to perform a specified sequence.
   4. Wires: Graphical elements used to form logical connections between microblocks and between logical I/O.
   5. Reference Labels: Similar to wires, in that they are used to form logical connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
   6. Parameter: A value that may be tied to the input of a microblock.
   7. Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields and shall contain 'push buttons' for the purpose of selecting default parameter settings.
   8. Icon: A graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
   9. Menu bar Icon: An icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.
   10. Live Graphical Programs: All input/output data, calculated data and set points shall be displayed in a 'live' real time mode.

6.08 SYSTEM NETWORK DEVICES

A. Archival Central Data Server (ADS):
   1. Processor: Intel Xeon CPU, compatible with quad core processors.
   2. Memory: Capacity: 2x16 GB.
      a. Speed and Type: DDR4 1800 MHz
      b. Expandable Capacity: 64 GB
      c. 32 GB or more recommended for the Windows 64 bit version.
   3. Hard Drives: (2) 4 TB RAID enabled
      a. Minimum Average Seek Time: <10ms.
      b. Cache Buffer Size: 256K.
      c. MTBF of 100,000 power-on hours.
   4. Backup BD/RW Drive: (1)
      a. 2 MB of data buffer.
      b. Average access time of 150 ms or less.
      c. MTBF of 100,000 power-on hours.

5. Graphical Card: 1920 x 1080 pixels at 60 Hz.
6. Network Card: (1) 100/1000 Mb TCP/IP adapter.
7. Ports: (4) 2.0 USB (2) 3.0 USB
8. Interface accessories:
    a. Wireless 101 enhanced Keyboard, Full upper- and lowercase ASCII keyset, numeric keypad, and 12 programmable function keys.
    b. Wireless 3 Button Mouse, w scroll wheel, Optical.
    c. Wireless operation within up to 72 inches in front of workstation.

B. Operator Workstation (OWS):
1. Processor: I7 Quad core 3.2 GHz.
2. Onboard RAM: Capacity: 2x16 GB.
    a. Speed and Type: DDR4 1800 MHz
    b. Expandable Capacity: 64 GB
3. Internal Hard Drives: (1) 2 TB.
    a. Minimum Average Seek Time: <10ms.
    b. Cache Buffer Size: 256K.
    c. MTBF of 100,000 power-on hours.
4. Backup BD/RW Drive: (1)
    a. 2 MB of data buffer.
    b. Average access time of 150 ms or less.
    c. MTBF of 100,000 power-on hours.
5. Graphics Card: 1920 x 1080 pixels at 60 Hz. Energy Star compliant.
6. Network Card: (1) 100/1000 Mb TCP/IP adapter.
7. Ports: (4) 2.0 USB (2) 3.0 USB
8. Interface accessories:
    a. Wireless 101 enhanced Keyboard, Full upper- and lowercase ASCII keyset, numeric keypad, and 12 programmable function keys.
    b. Wireless 3 Button Mouse, w scroll wheel, Optical.
    c. Wireless operation within up to 72 inches in front of workstation.

C. Graphics Monitor:
1. LED Color display with 24” diagonal viewable area.
2. Resolution: 1920 x 1080 pixels at 60 Hz.
3. Input signal: HDMI
4. Aspect Ratio: 16 to 9.
5. Antiglare display.
6. Dynamic Contrast Ratio: 50000 to 1.
7. Brightness: 250 cd/sq. m.
8. Tilt adjustable base.
9. Energy Star compliant.
10. Include applicable cabling to connect devices.

D. Thin Client Web Stations (TCWS): The Owner shall provide (as desired) Thin Client Stations (TCS)(Web-Browsers). The Thin Client Stations (TCS) shall be general purpose and commercially available, with sufficient memory and processor capacity to perform all functions described in this specification. The Thin Client Stations (TCS) shall allow for command entry, information management, network alarm management, and data base management functions. A current released open browser (Explorer/Firefox/Chrome) shall only be required as the GUI and a valid connection to the server network. No installation of any custom or special software shall be required to be installed to access the BMS via a web browser. Local and Remote interface shall from a Web Browser and the Building Management System shall be over a

TCP/IP LAN or WAN connection, and offer encryption using 128 bit encryption within Secure Socket Layers (SSL). Communication protocol shall be Hyper Text Transfer Protocol (HTTP). The Thin Client Web stations shall include the following components:

1. No special software shall be required on the TCSW(s) to access the BMS.
2. Processor, Memory and Hard Drive capacities: As desired by owner.
3. Latest release Windows 64-bit version.
4. Graphical Display: Video card & LCD monitor 1024 x 768 resolution or greater.
5. 1 GB DDR5 memory
6. Network Support: 100/1000 Mb TCP/IP adapter.

E. Web Appliances: The BMS thin client architecture shall take advantage of the web-browsers built into web appliances. The BMS Contractor shall provide additional features that include connection to the BMS from the following components, as a minimum:

1. Web-Tablets
2. Smart-Phones

F. Portable Operator Terminal (POT): Portable operator terminals shall support all controllers within the system on a direct connect communications basis. When used to access First or Second Tier controllers, the portable operator terminal shall utilize the standard operator workstation software, as previously defined. When used to access Application Specific Controllers (B-ASC), the portable operator terminal shall utilize either the standard operator workstation software, as previously defined, or controller specific utility software.

1. 15 inch diagonal or larger high-definition WLED antiglare color display with a 1920 x 1080 pixel resolution and a brightness of 300 nits.
2. One (1) 2.4 Gigahertz Dual Core I5 processor
3. One (1) DIMM of 8 GB DDR4 RAM, expandable to 16 GB
4. One (1) 1 TB Hard Drive with 128MB cache buffer, seek time less than 10ms
5. One (1) 4 GB Video Card.
6. Four (4) USB 2.0 ports.
7. One (1) TCP/IP ethernet port
8. One (1) 9-cell, 81 Watt-hour lithium ion battery
9. One (1) AC power supply adapter.
10. Integral Wi-Fi and Bluetooth technologies.
11. Integral key keyboard w/ Full upper- and lowercase ASCII keyset.
12. Integral Touchpad with two buttons or equivalent pointing device.
13. (1) Wireless 3-button mouse w/ wheel
14. (1) Carrying case.

G. Touch Screen Display (TSD): The location of the Touch Screen Display (TSD) shall be as shown on the project drawings, as determined by the owner or engineer, unless noted elsewhere. The Touch Screen Display (TSD) shall allow the operator to monitor and control the system via color images of floor plans, equipment schematics, control animations and database values. The Touch Screen Display (TSD) shall allow interaction of the operator with the system. Each screen shall be programmed for the purpose of selecting different equipment, activating control of remote devices, changing setpoints, etc. The TSD shall display various graphic images, custom menus, floor plans, equipment schematics, and keypads. In addition, operators can input information in the form of setpoints, command output devices such as fans, pumps or lighting circuits, or other functions of the BMS, to enable operators to easily view and modify system information. Each Touch Screen Display (TSD) location has the capability for accessing the BMS control network's information, dependent upon the user's Role and security access level assigned. Any parameter or I/O point values found in the BMS, including inputs, outputs, and calculated variables. The Touch Screen Display (TSD) shall also be capable of receiving both Alarming and Trending functions. Visual and Audible Alerts identical to the

Workstation Functionality.

1. The Touch Screen Display (TSD) shall be surface/flush mounted on a wall or on the face of a separate control enclosure.
2. The Touch Screen Display (TSD shall have as a minimum the following features:
    a. Touch Enabled Display: LCD/LED: Resolution of 1024 pixels by 768, 13 inch diagonal.
    b. Audio: An audible sound shall issue upon touch, programmable.
    c. Memory: 2 GB RAM memory.
    d. Media Storage: 100 GB
    e. Ports: (1) 100/1000 Mb TCP/IP adapter.
    f. (2) USB ports
    g. Real Time Clock (RTC)
    h. Power Supply: 24 VAC, 50/60 Hz 20 percent swings in supply voltage.

H. Router and Switches (100/1000 MBPS): The BMS network router/switches shall connect directly to the architecture using standard TCP/IP protocol at a minimum of 100 mbps and shall provide communication connections between individual SNCs, Servers, OWS and other TCP/IP networked devices.

1. Manufacturers:
    a. Cisco
    b. Engineer approved equal

6.09 BUILDING MANAGEMENT SYSTEM PRINTERS

A. Laser Printer - Black and White:

1. Laser print with 1200 x 1200 dots per inch (dpi) black and white
2. 20 page per minute rated print speed.
3. Print buffer with at least 64 MB of RAM, expandable to at least 256 MB.
4. Capable of handling letter- and legal-size paper.
5. One paper tray with 150 sheet capacity, and one tray with 225 sheet capacity.
6. 1500 page toner/cartridge capacity.
7. (1) 100/1000 Mb TCP/IP adapter.
8. Wi-Fi Network connection.
9. Complies with Energy Star requirements.

6.10 UNINTERRUPTABLE POWER SUPPLY (UPS):

A. Backup Power Capacity Sizing: The Uninterruptable Power Supply shall be sized to provide the equipment with a minimum backup power for 15 minutes at full load. The UPS shall conform to Class 2 overcurrent protection.

B. Power Line Filtering: The UPS shall have combined 1 percent line and load regulation with 100 micro-second response time for 50 percent load changes. Built in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure. Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse mode noise attenuation of 65 dB.
4. Minimum common mode noise attenuation of 150 dB at 40 to 100 Hz.

C. Manufacturers:

1. APC
2. Engineer approved equal

6.11 SUPERVISORY NETWORK BUILDING CONTROLLER (SNC)

A. Overview: The Supervisory Network Building Controller(s) (SNC) are designed to manage communications between itself and other peer-to-peer Supervisory Network Controllers (SNC) and with any Building Management System BACnet TCP/IP, SNMP and Niagara 4 Fox networked connected Operator workstations (OWS) that are part of the Building Management System. Additionally, the Supervisory Network Building Controller(s) (SNC) are to manage the communications between its communications sub-network Building Level controller(s) (B-BC), Advanced Application Controller(s) (B-AAC), and Application Specific Controller(s) (B-ASC). The SNC shall perform control and operating strategies for the various HVAC and integrated systems controlled utilizing information from any of the distributed DDC controllers connected to the Building Management System. The SNC shall be fully programmable to meet the unique requirements of the facility. The use of a proprietary communication protocol for peer to peer communications between SNC's shall not be acceptable.

B. Open Protocols (Standard): The SNC shall be provided with BACnet, LON, Modbus, N2, SNMP, KNx Open Communications protocols by default.

C. Embedded Software: The SNC shall have embedded "Setup Wizards" controller programming software

D. Standard Programs: The SNC shall be capable of executing application control programs to provide:
   1. Calendar functions.
   2. Scheduling.
   3. Trending.
   4. Alarm monitoring and routing.
   5. Time synchronization.
   6. Integration of LonWorks, BACnet, and MODBUS controller data.
   7. Network management functions for all SNC, PEC and ASC networked devices.

E. Hardware Features: The SNC shall provide the following hardware features as a minimum:
   1. Ports: Two 10/100 Mbps Ethernet ports/ Two Isolated RS-485 ports with biasing switches.
   2. One USB Flash Drive
   3. Onboard Memory: 1 GB RAM / 4 GB Flash Total Storage / 2 GB User Storage
   4. MicroSD Memory Card with Encrypted Safe Boot Technology
   5. Wireless: Wi Fi (Client or WAP)
   6. Expansion Bus: High Speed Field Bus Expansion
   7. Operating Temperature: Minus 4 to 140 degrees F Ambient
   8. Integrated 24 VAC/DC Power Supply

F. Connectivity: The SNC shall support standard Web browser access via the LAN/WAN network, supporting a minimum of 16 simultaneous users.

G. Alarming: The SNC shall provide alarm recognition, storage, routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers. The SNC shall be able to route any alarm condition to any defined user location whether connected to a local network, remote via cellular modem, or wide area network. Alarm generation shall be selectable for annunciation type and acknowledgement requirements. Alarms shall be annunciated in any of the following manners as defined by the user: The following shall be recorded by the SNC for each alarm (at a minimum):
   1. Time and date.
   2. Equipment (air handler #, access way, etc.).
   3. Acknowledge time, date, and user who issued acknowledgement.

H. Device Security: The SNC shall support the following security functions.

1. Module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted.
2. Role Broadcast Access Control (RBAC) for managing user roles and permissions.
3. Require users to use strong credentials.
4. Data in Motion and Sensitive Data at Rest be encrypted.
5. LDAP and Kerberos integration of access management.

I. Data Structures: The SNC shall support the following data modeling structures to utilize Search; Hierarchy; Template; and Permission functionality:
1. Metadata: Descriptive tags to define the structure of properties.
2. Tagging: Process to apply metadata to components
3. Tag Dictionary

J. Data Templates: The SNC shall employ template functionality. Templates are a containerized set of configured data tags, graphics, histories, alarms... that are set to be deployed as a unit controlled upon manufacturer's controller and relationships. All lower level communicating controllers (PEC, AUC, AVAV, VFD…) shall have an associated template file for reuse on future project additions.

K. Software Support: The SNC shall be provided with a 5 Year Software Maintenance license. Labor to implement not included.

6.12 BUILDING CONTROLLER - BACNET (B-BC)

A. Controller Applications: Application of a B-BC controller shall include the following equipment:
1. Central Plant Controls (B-BC)
2. Air Handling Units - Constant Volume (B-BC)
3. Air Handling Units - Variable Volume (B-BC)
4. Roof Top Units – Packaged (B-BC)

B. B-BC controllers shall be fully programmable to meet the unique requirements of the facility it shall control. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara 4 Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".

C. B-BC controllers shall be application programmable and shall always maintain their certification. All control sequences within or programmed into the B-BC controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.

D. The B-BC controllers shall be capable of daisy-chain IP communications with other B-BC's and peer-to-peer communications with SNC's and with any OWS connected to the BMS, whether the OWS is directly connected, connected via cellular modem or connected via the Internet.

E. The communication protocols utilized for peer-to-peer communications between B-BC's shall be BACnet TCP/IP or Niagara 4 Fox or. Use of a proprietary communication protocol for peer-to-peer communications between B-BC's is not allowed.

F. The B-BC controller shall be provided with a 1 Year Software Maintenance license. Labor to implement not included if greater than 1 year is required.

G. BACnet: The control of the HVAC equipment shall be accomplished using a BACnet direct digital controlled devices with BTL listed PICS.

H. Programming Functional Requirements:
1. The B-BC controller shall have standard and custom HVAC programs which shall be modifiable to provide the Division 23" HVAC Sequence of Operations".
2. Programming software shall be embedded into the B-BC controller. The B-BC controller shall not require any external configuration tool or programming tool. All configuration and programming tasks shall be accomplished and accessible from within the embedded

Niagara 4 environment.

3. The B-BC controller shall maintain the Native Graphical Programming Language and graphics, fully programmable and configurable from any Niagara N4 Framework™ platform, not requiring any external configuration or programming tool. The Native programming software and “Setup Wizard” shall be embedded within the controller.
4. The B-BC controller shall allow downloads and uploads from any Niagara N4 Framework™ platform, including providing offline program simulation.
5. The B-BC controller shall be part of a networked system or allow for standalone operation.
6. The B-BC controller shall provide continuous Adaptive Integral Algorithm Control Loop tuning.
7. The B-BC controller shall have a loop execution response time of 1 second.
8. The B-BC controller shall have a software notifications, when connected to a network:
   a. Significant Event Notification
   b. System Periodic Update
   c. Detection of Network Failure.
9. The B-BC controller shall provide for “user defined” Network Variables (NV) for customized configurations and naming using Niagara N4 Framework™.
10. The B-BC controller shall support 240 Network Variables with a byte count of 31 per variable.
11. The B-BC controller shall support 960 separate data values.

I. The B-BC controller shall support the following security functions.
   1. Module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted.
   2. Role-Based Access Control (RBAC) for managing user roles and permissions.
   3. Require users to use strong credentials.
   4. Data in Motion and Sensitive Data at Rest be encrypted.

J. Hardware Requirements:
   1. Approvals and Listings: The controller shall have the following certifications, listings, and approvals:
      a. BACnet Application Specific Controller (B-BC)
      b. FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
      c. UL916 (Open Energy Management Equipment) with plenum rating.
      d. CSA (LR95329-3) Listed
      e. Canadian Standard C108.8 (radiated emissions).
      f. European Consortium standards: EN 61000-6-1; 2001 EN 61000-6-3; 2001
   2. The B-BC Controller shall provide the following hardware features as a minimum:
      a. Two10/100 Mbps Ethernet ports.
      b. Two RS-485 ports, one isolated and one non-isolated, with biasing switches.
      c. Two USB 2.0 ports
      d. One HMI port to connect onboard or remote HMI.
      e. Processors: The B-BC controller shall have two ARM 9 32-bit processor, 1 GHz microprocessors, Host and Comm. The Host processor shall provide FLASH memory for HVAC application programming, with RAM memory for HVAC program execution and data storage. The FLASH memory shall be retained for a minimum of ten years, a battery for memory retainage shall not be acceptable. The Comm processor shall manage the network communications.
      f. 1 GB RAM
      g. 512 KB MRAM
      h. 4 GB Flash Memory

i. Environmental Ratings: The controller shall be function within an operating environment of 32 to 122 degrees F and 5 to 95 percent relative humidity, non-condensing.
j. Integrated 24 VAC/DC Global Power Supply
k. Real Time Clock (RTC): The controller shall have an internal Real Time Clock (RTC). The RTC shall allow for stand-alone operation or reference if Network Master Time clock communication function is interrupted. The RTC shall provide 24 hours, 365 days, multi-year calendar, day of week, including automatic daylight savings, configured for start and stop dates scheduling. The RTC shall have a time accuracy of plus or minus 1 minute per month at 77 degrees F and shall maintain its settings upon a loss of device power for a minimum of 24 hours at 32 to 122 degrees F.
l. Bus Status Indication (Comm): A visible LED shall provide indication of the controller's communication status:
    1) Bootloader running - MS/TP communication is present.
    2) Bootloader running - MS/TP token is not present.
    3) Bootloader not running - Processor missing bootloader image.
    4) Communications - Processor is not running
m. Device Status Indication (Host): A visible LED shall provide indication of the internal program functional status.
    1) B-BC Controller - Operating normally.
    2) B-BC Controller - In process of program download.
    3) B-BC Controller - In manual mode, under control of software tool.
    4) B-BC Controller - Lost Configuration.
    5) B-BC Controller – Low or No power, possible damage
    6) B-BC Controller - Host Processor not operating.
n. Housing: The housing shall be UL plenum rated, with panel of din rail mounting.
o. Terminal Connections: The controller's wire connectors shall allow for quick disconnection of external wiring, without removing the wire from the connector. The wire connectors shall have color coded labels.
p. Field Wire connections: The B-BC controller shall have Digital Inputs (DI), Digital Outputs (DO), Analog Outputs (AO), Universal Inputs (UI), Internal Velocity Pressure sensor, and damper actuator (optional), as required to meet the Sequence of operations.
q. The Universal inputs (UI) shall be configurable as binary N.O./N.C. inputs, analog resistive inputs (0 to 10K or 20K ohm NTC), analog voltage inputs (0 to 10 VDC), or analog current inputs (4 to 20 mA).
r. The Digital Inputs (DI) shall be configurable as N.O., N.C or 15 Hz pulse counters.
s. The Analog outputs (AO) shall be configurable as 0 or 2 to 10 Vdc or as 4 to 20 mA.
t. The Digital Outputs (DO) shall be configurable as N.O. or N.C. and rated to switch 30 Vac/Vdc at 500 mA, or Relay outputs, (RO) rated for 1 Amp.
u. Onboard Power VDC Supply: The B-BC controller shall have one (1) integral 20 VDC 75 mA power supply, plus or minus 10 percent for external sensors. If the controller lacks a comparable internal power supply, a fully isolated, enclosed, current limited and regulated UL listed DC power supply for each shall be provided.
v. Communications Field Bus: The B-BC controller shall a two wire, polarity insensitive communication via bus which provides 18 Vdc power and communications between enabled devices

6.13 ADVANCED APPLICATION CONTROLLER - BACNET (B-AAC)

A. The Advanced Application Specific Controller (B-AAC) shall be designed specifically to allow for custom programming to control the Building Management System's equipment, where a B-ASC

controllers programming is insufficient to meet the sequence of operations.

B. Controller Applications: Application of a B-AAC controller include the following equipment:
   1. Unit Ventilators
   2. Fan or Blower Coil Units
   3. Heat Pump Units
   4. Natural Convection units
   5. Radiant panels.
   6. Room Pressure control (Regulated volume (pressurization/de-pressurization).
   7. Temperature, humidity, dispersed CO2, occupancy, and emergency control.

C. All B-AAC programming shall comply with standard application programmable and shall at all times maintain their certification. All control sequences within or programmed into the B-AAC shall be stored in non-volatile memory. Device dependent upon the presence of a battery for memory retainage shall not be acceptable.

D. Minimum Programming Functional Requirements: The B-AAC shall not require any external configuration tool or programming tool. All configuration and programming tasks shall be accomplished and accessible from within the Niagara 4 environment. B-AAC s shall support at minimum the following control sequences:
   1. General purpose control loops, linear and non-linear
   2. Demand Limit Control strategies,
   3. Setpoint reset
   4. Adaptive intelligent recovery
   5. Time of Day Reset.
   6. Start/Stop/Status loops.
   7. Boolean Logic functions (i.e. If/Then/Else ladder logic)
   8. Math Function loops.

E. Minimum Hardware Functional Requirements: The B-AAC shall be capable of either integrating with other devices or standalone room level control operation. The B-AAC shall have an internal time clock with the ability to automatically revert from a master time clock on failure.

F. BACnet: The control of the equipment shall be accomplished using a BACnet direct digital controlled devices with BTL listed PICS.

G. Programming Functional Requirements:
   1. The B-AAC controller shall have standard and custom HVAC programs which shall be modifiable to provide the Specification Section 23 09 93"sequence of operations".
   2. The B-AAC controller shall maintain the Native Graphical Programming Language and graphics, fully programmable and configurable from any Niagara N4 Framework™ platform, not requiring any external configuration or programming tool. The Native programming software and “Setup Wizard” shall be embedded within the controller.
   3. The B-AAC controller shall allow downloads and uploads from any Niagara N4 Framework™ platform, including providing offline program simulation.
   4. The B-AAC controller shall be part of a networked system or allow for standalone operation.
   5. The B-AAC controller shall provide continuous Adaptive Integral Algorithm Control Loop tuning with a loop execution response time of 1 second.
   6. The B-AAC controller shall have a software notifications, when connected to a network:
      a. Significant Event Notification
      b. System Periodic Update
      c. Detection of Network Failure.

7. The B-AAC controller shall provide for “user defined” Network Variables (NV) for customized configurations and naming using Niagara N4 Framework™.
8. The B-AAC controller shall support 240 Network Variables with a byte count of 31 per variable.
9. The B-AAC controller shall support 960 separate data values.

H. Hardware Requirements:
1. Control Processors: The controller shall have two microprocessors, Host and Comm. The Host processor shall provide FLASH memory for HVAC application programming, with RAM memory for HVAC program execution and data storage. The FLASH memory shall be retained for a minimum of ten years, a battery for memory retainage shall not be acceptable. The Comm processor shall manage the network communications.
2. Environmental Ratings: The B-AAC controller shall be function within an operating environment of 32 to 122 degrees F and 5 to 95 percent relative humidity, non-condensing.
3. Approvals and Listings: The B-AAC controller shall have the following certifications, listings, and approvals:
   a. BACnet Advanced Application Controller (B-AAC)
   b. FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
   c. UL916 (Open Energy Management Equipment) with plenum rating.
   d. CSA (LR95329-3) Listed
   e. Canadian Standard C108.8 (radiated emissions).
   f. European Consortium standards: EN 61000-6-1; 2001 EN 61000-6-3; 2001
4. Device Status Indication (Host): A visible LED shall provide indication of the internal program functional status.
   a. Controller - Operating normally.
   b. Controller - In process of program download.
   c. Controller - In manual mode, under control of software tool.
   d. Controller - Lost Configuration.
   e. Controller – Low or No power, possible damage
   f. Controller - Host Processor not operating.
5. Bus Status Indication (Comm): A visible LED shall provide indication of the B-AAC controller’s communication status:
   a. Bootloader running - MS/TP communication is present.
   b. Bootloader running - MS/TP token is not present.
   c. Bootloader not running - Processor missing bootloader image.
   d. Communications - Processor is not running
6. Internal Real Time Clock (RTC): The B-AAC controller shall have an internal Real Time Clock (RTC). The RTC shall allow for stand-alone operation or reference if Network Master Time clock communication function is interrupted. The RTC shall provide 24 hours, 365 days, multi-year calendar, day of week, including automatic daylight savings, configured for start and stop dates scheduling. The RTC shall have a time accuracy of plus or minus 1 minute per month at 77 degrees F and shall maintain its settings upon a loss of device power for a minimum of 24 hours at 32 to 122 degrees F.
7. Housing: The housing shall be UL plenum rated, with panel of din rail mounting.
8. Terminal Connections: The B-AAC controller’s wire connectors shall allow for quick disconnection of external wiring, without removing the wire from the connector. The wire connectors shall have color coded labels.
9. Field Wire connections: The B-AAC controller shall have Digital Inputs (DI), Digital Outputs (DO), Analog Outputs (AO), Universal Inputs (UI), Internal Velocity Pressure sensor, and damper actuator (optional), as required to meet the Sequence of operations.

a. The Universal inputs (UI) shall be configurable as binary N.O./N.C. inputs, analog resistive inputs (0 to 10K or 20K ohm NTC), analog voltage inputs (0 to 10 VDC), or analog current inputs (4 to 20 mA).
b. The Digital Inputs (DI) shall be configurable as N.O., N.C or 15 Hz pulse counters.
c. The Analog outputs (AO) shall be configurable as 0 or 2 to 10 Vdc or as 4 to 20 mA.
d. The Digital Outputs (DO) shall be configurable as N.O. or N.C. and rated to switch 30 Vac/Vdc at 500 mA, or Relay outputs, (RO) rated for 1 Amp.

10. Communications Field Bus: The B-AAC controller shall a two wire, polarity insensitive communication via bus which provides 18 Vdc power and communications between Sylk enabled devices
11. Onboard Power VDC Supply: The B-AAC controller shall have one (1) integral 20 VDC 75 mA power supply, plus or minus 10 percent for external sensors. If the controller lacks a comparable internal power supply, a fully isolated, enclosed, current limited and regulated UL listed DC power supply for each shall be provided.

6.14 APPLICATION SPECIFIC CONTROLLER - BACNET (B-ASC)

A. The Application Specific Controller (B-ASC) shall be designed specifically to allow for specific application with the capability for custom programming to control the Building Management System's equipment.

B. Controller Applications: Application of the B-ASC controller include the following equipment:
1. Unit Ventilators
2. Fan or Blower Coil Units
3. Heat Pump Units
4. Natural Convection units
5. Radiant panels.
6. Room Pressure control (Regulated volume (pressurization/de-pressurization).
7. Temperature, humidity, dispersed CO2, occupancy, and emergency control.

C. All B-ASC programming shall comply with standard application programmable and shall at all times maintain their certification. All control sequences within or programmed into the B-ASC shall be stored in non-volatile memory. Device dependent upon the presence of a battery for memory retainage shall not be acceptable.

D. Minimum Hardware Functional Requirements: The B-ASC shall be capable of either integrating with other devices or standalone room level control operation. The B-ASC shall have an internal time clock with the ability to automatically revert from a master time clock on failure.

E. BACnet: The control of the equipment shall be accomplished using a BACnet direct digital controlled devices with BTL listed PICS.

F. Programming Functional Requirements:
1. Minimum Programming Functional Requirements: The B-ASC shall not require any external configuration tool or programming tool. All configuration and programming tasks shall be accomplished and accessible from within the Niagara 4 environment. B-ASC s shall support at minimum the following control sequences:
a. General purpose control loops, linear and non-linear
b. Demand Limit Control strategies,
c. Setpoint reset
d. Adaptive intelligent recovery
e. Time of Day Reset.
f. Start/Stop/Status loops.
g. Boolean Logic functions (i.e. If/Then/Else ladder logic)

h. Math Function loops.

2. The B-ASC controller shall have standard and custom HVAC programs which shall be modifiable to provide the Division 23 Section “HVAC Equipment Sequence of Operations".
3. The B-ASC controller shall maintain the Native Graphical Programming Language and graphics, fully programmable and configurable from any Niagara N4 Framework™ platform, not requiring any external configuration or programming tool. The Native programming software and “Setup Wizard” shall be embedded within the controller.
4. The B-ASC controller shall allow downloads and uploads from any Niagara N4 Framework™ platform, including providing offline program simulation.
5. The B-ASC controller shall be part of a networked system or allow for standalone operation.
6. The B-ASC controller shall provide continuous Adaptive Integral Algorithm Control Loop tuning with a loop execution response time of 1 second.
7. The B-ASC controller shall have a software notifications, when connected to a network:
   a. Significant Event Notification
   b. System Periodic Update
   c. Detection of Network Failure.
8. The B-ASC controller shall provide for “user defined” Network Variables (NV) for customized configurations and naming using Niagara N4 Framework™.
9. The B-ASC controller shall support 240 Network Variables with a byte count of 31 per variable.
10. The B-ASC controller shall support 960 separate data values.

G. Hardware Functional Requirements:
   1. Control Processors: The B-ASC controller shall have two microprocessors, Host and Comm. The Host processor shall provide FLASH memory for HVAC application programming, with RAM memory for HVAC program execution and data storage. The FLASH memory shall be retained for a minimum of ten years, a battery for memory retainage shall not be acceptable. The Comm processor shall manage the network communications.
   2. Environmental Ratings: The B-ASC controller shall be function within an operating environment of 32 to 122 degrees F and 5 to 95 percent relative humidity, non-condensing.
   3. Approvals and Listings: The B-ASC controller shall have the following certifications, listings, and approvals:
      a. BACnet Application Specific Controller (B-ASC)
      b. FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
      c. UL916 (Open Energy Management Equipment) with plenum rating.
      d. CSA (LR95329-3) Listed
      e. Canadian Standard C108.8 (radiated emissions).
      f. European Consortium standards: EN 61000-6-1; 2001 EN 61000-6-3; 2001
   4. Device Status Indication (Host): A visible LED shall provide indication of the internal program functional status.
      a. Controller - Operating normally.
      b. Controller - In process of program download.
      c. Controller - In manual mode, under control of software tool.
      d. Controller - Lost Configuration.
      e. Controller – Low or No power, possible damage
      f. Controller - Host Processor not operating.
   5. Bus Status Indication (Comm): A visible LED shall provide indication of the B-ASC controller’s communication status:

a. Bootloader running - MS/TP communication is present.
b. Bootloader running - MS/TP token is not present.
c. Bootloader not running - Processor missing bootloader image.
d. Communications - Processor is not running

6. Internal Real Time Clock (RTC): The B-ASC controller shall have an internal Real Time Clock (RTC). The RTC shall allow for stand-alone operation or reference if Network Master Time clock communication function is interrupted. The RTC shall provide 24 hours, 365 days, multi-year calendar, day of week, including automatic daylight savings, configured for start and stop dates scheduling. The RTC shall have a time accuracy of plus or minus 1 minute per month at 77 degrees F and shall maintain its settings upon a loss of device power for a minimum of 24 hours at 32 to 122 degrees F.
7. Housing: The housing shall be UL plenum rated, with panel of din rail mounting.
8. Terminal Connections: The B-ASC controller's wire connectors shall allow for quick disconnection of external wiring, without removing the wire from the connector. The wire connectors shall have color coded labels.
9. Field Wire connections: The B-ASC controller shall have Digital Inputs (DI), Digital Outputs (DO), Analog Outputs (AO), Universal Inputs (UI), Internal Velocity Pressure sensor, and damper actuator (optional), as required to meet the Sequence of operations.
   a. The Universal inputs (UI) shall be configurable as binary N.O./N.C. inputs, analog resistive inputs (0 to 10K or 20K ohm NTC), analog voltage inputs (0 to 10 VDC), or analog current inputs (4 to 20 mA).
   b. The Digital Inputs (DI) shall be configurable as N.O., N.C or 15 Hz pulse counters.
   c. The Analog outputs (AO) shall be configurable as 0 or 2 to 10 Vdc or as 4 to 20 mA.
   d. The Digital Outputs (DO) shall be configurable as N.O. or N.C. and rated to switch 30 Vac/Vdc at 500 mA, or Relay outputs, (RO) rated for 1 Amp.
10. Communications Field Bus: The B-ASC controller shall a two wire, polarity insensitive communication via bus which provides 18 Vdc power and communications between enabled devices
11. Onboard Power VDC Supply: The B-ASC controller shall have one (1) integral 20 VDC 75 mA power supply, plus or minus 10 percent for external sensors. If the controller lacks a comparable internal power supply, a fully isolated, enclosed, current limited and regulated UL listed DC power supply for each shall be provided.

6.15 VARIABLE AIR VOLUME CONTROLLER - BACNET (VAV)(B-ASC)

A. The VAV Application Specific Controller (B-ASC) shall be designed specifically to allow for specific Variable Air Volume and Constant Volume applications with the limited capability for custom programming to control the Building Management System's equipment.

B. Controller Applications: Application of the VAV controller (B-ASC) include the following equipment:
   1. Variable Air Volume, Constant Volume or Terminal units.
   2. Fan Powered VAV Terminal unit (Series or Parallel).
   3. Supply and/or Exhaust Air Volume terminal units.
   4. Constant Volume, Dual-Duct terminal unit.
   5. Room Pressure control (Regulated volume (pressurization/de-pressurization).
   6. Temperature, humidity, dispersed CO2, occupancy, and emergency control.

C. BACnet: The control of the equipment shall be accomplished using a BACnet direct digital controlled devices with BTL listed PICS.

D. Programming Functional Requirements: The VAV controller (B-ASC) shall have standard and custom HVAC programs which shall be modifiable to provide the Specification Section 23 09 93"sequence of operations".

1. The VAV controller (B-ASC) shall maintain the Native Graphical Programming Language and graphics, fully programmable and configurable from any Niagara N4 Framework™ platform, not requiring any external configuration or programming tool. The Native programming software and “Setup Wizard” shall be embedded within the controller.
2. The VAV controller (B-ASC) shall allow downloads and uploads from any Niagara N4 Framework™ platform, including providing offline program simulation.
3. The VAV controller (B-ASC) shall be part of a networked system or allow for standalone operation.
4. The VAV controller (B-ASC) shall provide continuous Adaptive Integral Algorithm Control Loop tuning.
5. The VAV controller (B-ASC) shall have a loop execution response time of 1 second.
6. The VAV controller (B-ASC) shall have a software notifications, when connected to a network:
    a. Significant Event Notification
    b. System Periodic Update
    c. Detection of Network Failure.
7. The VAV controller (B-ASC) shall provide for “user defined” Network Variables (NV) for customized configurations and naming using Niagara N4 Framework™.
8. The VAV controller (B-ASC) shall support 240 Network Variables with a byte count of 31 per variable.
9. The VAV controller (B-ASC) shall support 960 separate data values.

E. Hardware Functional Requirements:
1. Control Processors: The controller shall have two microprocessors, Host and Comm. The Host processor shall provide FLASH memory for HVAC application programming, with RAM memory for HVAC program execution and data storage. The FLASH memory shall be retained for a minimum of ten years, a battery for memory retainage shall not be acceptable. The Comm processor shall manage the network communications.
2. Environmental Ratings: The controller shall be function within an operating environment of 32 to 122 degrees F and 5 to 95 percent relative humidity, non-condensing.
3. Approvals and Listings: The controller shall have the following certifications, listings, and approvals:
    a. BACnet Application Specific Controller (B-ASC)
    b. FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
    c. UL916 (Open Energy Management Equipment) with plenum rating.
    d. CSA (LR95329-3) Listed
    e. Canadian Standard C108.8 (radiated emissions).
    f. European Consortium standards: EN 61000-6-1; 2001 EN 61000-6-3; 2001
4. Device Status Indication (Host): A visible LED shall provide indication of the internal program functional status.
    a. Controller - Operating normally.
    b. Controller - In process of program download.
    c. Controller - In manual mode, under control of software tool.
    d. Controller - Lost Configuration.
    e. Controller – Low or No power, possible damage
    f. Controller - Host Processor not operating.
5. Bus Status Indication (Comm): A visible LED shall provide indication of the controller’s communication status:
    a. Bootloader running - MS/TP communication is present.
    b. Bootloader running - MS/TP token is not present.
    c. Bootloader not running - Processor missing bootloader image.

d. Communications - Processor is not running

6. Internal Real Time Clock (RTC): The VAV controller (B-ASC) shall have an internal Real Time Clock (RTC). The RTC shall allow for stand-alone operation or reference if Network Master Time clock communication function is interrupted. The RTC shall provide 24 hours, 365 days, multi-year calendar, day of week, including automatic daylight savings, configured for start and stop dates scheduling. The RTC shall have a time accuracy of plus or minus 1 minute per month at 77 degrees F and shall maintain its settings upon a loss of device power for a minimum of 24 hours at 32 to 122 degrees F.
7. Housing: The housing shall be UL plenum rated, with panel of din rail mounting.
8. Terminal Connections: The VAV controller (B-ASC)'s wire connectors shall allow for quick disconnection of external wiring, without removing the wire from the connector. The wire connectors shall have color coded labels.
9. Field Wire connections: The controller shall have Digital Inputs (DI), Digital Outputs (DO), Analog Outputs (AO), Universal Inputs (UI), Internal Velocity Pressure sensor, and damper actuator (optional), as required to meet the Sequence of operations.
    a. The Universal inputs (UI) shall be configurable as binary N.O./N.C. inputs, analog resistive inputs (0 to 10K or 20K ohm NTC), analog voltage inputs (0 to 10 VDC), or analog current inputs (4 to 20 mA).
    b. The Digital Inputs (DI) shall be configurable as N.O. or N.C.
    c. The Analog outputs (AO) shall be configurable as 0 or 2 to 10 Vdc or as 4 to 20 mA.
    d. The Digital Outputs (DO) shall be configurable as N.O. or N.C, and rated to switch 30 Vac/Vdc at 500 mA,
    e. The Internal Velocity Pressure sensor shall be a microbridge air flow sensor with dual restrictors, with a range of 0 to 1.5 inches w.c. and accuracy of plus or minus 2 percent full scale at 32 to 122 degrees F.
    f. The Damper actuator shall be Floating with a CW or CCW, 90 seconds rotation stroke of 95 degrees, and have a torque rating of 44 inch-lbs.
10. Communications Field Bus: The VAV controller (B-ASC) shall a two wire, polarity insensitive communication via bus which provides 18 Vdc power and communications between enabled devices
11. Onboard Power VDC Supply: The VAV controller (B-ASC) shall have one (1) integral 20 VDC 75 mA power supply, plus or minus 10 percent for external sensors. If the controller lacks a comparable internal power supply, a fully isolated, enclosed, current limited and regulated UL listed DC power supply for each shall be provided.

6.16 SYSTEM INPUT SENSORS

A. General Requirements: Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Current Switches (CS): Current actuated switches shall be self-powered, solid state with an adjustable trip current. The switches shall be selected by the BMS contractor to match the application and output requirements of the DDC system. The current sensing switch shall be self-powered with solid state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over current up to twice its trip point range. Approved applications of current sensing switches include monitoring of run status for fans, pumps, and other miscellaneous motor loads. The Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
    1. Acceptable manufacturers:
        a. Honeywell

b. Senva
c. Veris Industries

C. Differential Pressure Switch, Filter (DPS-F): Automatic reset type with Snap acting SPDT contacts rated for with 2 amps at 120 VAC pilot duty rating and with suitable scale range and differential adjustment for intended service. An installation kit shall be provided, including static pressure tops and tubing.
   1. Acceptable Manufacturers:
      a. Honeywell Controls
      b. Johnson Controls
      c. Cleveland Controls
      d. Dwyer Industrial
      e. or Engineer approved equal.

D. Differential Pressure Switch, Air (DPS-A): Automatic reset type with Snap acting SPDT contacts rated for with 2 amps at 120 VAC pilot duty rating and with suitable scale range and differential adjustment for intended service
   1. An installation kit shall be provided, including static pressure tops and tubing.
   2. Acceptable Manufacturers:
      a. Honeywell Controls
      b. Johnson Controls
      c. Cleveland Controls
      d. Dwyer Industrial
      e. or Engineer approved equal.

E. Differential Pressure Switch, Fluid (DPS-F): Automatic reset type with Snap acting SPDT contacts rated for with 2 amps at 120 VAC pilot duty rating and with suitable scale range and differential adjustment for intended service
   1. Acceptable Manufacturers:
      a. Honeywell Controls
      b. Johnson Controls
      c. Cleveland Controls
      d. Dwyer Industrial
      e. or Engineer approved equal.

F. Differential Pressure Transmitters (DPT): General Pressure Transmitter Requirements:
   1. Range: Selection to provide full coverage of the to the measured range.
   2. Over Pressure protection: 100 percent pressure range
   3. 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
   4. Rated for local environment, minimum NEMA-1.
   5. plus, or minus 1 percent of full scale.
   6. .04 percent linearity, hysteresis, and repeatability.
   7. 20 to 1 ratio turndown.
   8. less than .033 degrees F over 40 to 100 degrees F.
   9. 0.5 percent fill scale.
   10. Features: Non-interactive zero and span adjustments adjustable from the outside cover.
   11. Auxiliary devices: Air bleed and bypass valve assembly with shut off valves in the sensing lines
   12. Acceptable Manufacturers:
      a. Honeywell Controls
      b. Johnson Controls
      c. Veris
      d. Setra.

e. Engineer approved equal

G. Gas Detection - Carbon Dioxide Sensor (CO2): The carbon dioxide sensor (CO2) shall be rated for the design application. The CO2 sensor shall measure the carbon dioxide concentrations and shall work on the non-dispersive infrared (NDIR) operating principle with either an ambient or duct gas sampling method. The CO2 sensor shall be monitored by the BMS. The CO2 sensors shall have a local LED readout of the ppm of CO2. The BMS shall trend the CO2 concentration of each system over a 24 hour period.

H. Gas Detection - Carbon Dioxide – Wall (CO2-W): Wall Carbon Dioxide Sensors shall utilize Non-dispersive infrared technology (N.D.I.R.) with the following features:
1. less than one minute.
2. 0 to 2000 PPM CO2
3. plus, or minus 5 percent or 75 PPM
4. Jumper Selectable: 0 or 4 to 20 mA, 0 to 10 VDC.
5. 15 to 130 degrees F
6. High impact plastic enclosure.
7. N.O. or N.C. operation, Max 30 VAC, 0.5 A, Class 2.
8. 10 ppm
9. External Load: Current Output: 4-20mA, Maximum 500 ohm load resistance. Voltage Output: 0-5VDC, Minimum 1,000 ohm load resistance.
10. 20 to 30 VAC (18 to 30 VDC), Class 2.
11. Operating Life Expectancy: 10 Years
12. Acceptable Manufacturers:
    a. Honeywell Controls
    b. Johnson Controls
    c. Veris Industries
    d. Senva

I. Gas Detection - Carbon Dioxide – Duct (CO2-D): Duct Carbon Dioxide Sensors shall utilize Non-dispersive infrared technology (N.D.I.R.) with the following features:
1. less than one minute.
2. 0 to 2000 PPM CO2
3. plus, or minus 5 percent or 75 PPM
4. Jumper Selectable: 0 or 4 to 20 mA, 0 to 10 VDC.
5. 15 to 130 degrees F
6. High impact plastic enclosure.
7. N.O. or N.C. operation, Max 30 VAC, 0.5 A, Class 2.
8. 10 ppm
9. External Load: Current Output: 4-20mA, Maximum 500 ohm load resistance. Voltage Output: 0-5VDC, Minimum 1,000 ohm load resistance.
10. 20 to 30 VAC (18 to 30 VDC), Class 2.
11. Operating Life Expectancy: 10 Years
12. Acceptable Manufacturers:
    a. Honeywell Controls
    b. Johnson Controls
    c. Veris Industries
    d. Senva

J. Pressure Traverse Probe - Static: Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.
1. Acceptable manufacturers:

a. Cleveland Controls

K. Pressure Static Air Probe - Shielded: A shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding. A suitable probe for indoor and outdoor locations shall be provided.

L. Pressure Transmitters, Static - Air (SPT-A): Stainless steel diaphragm construction, Suitable for service medium, Non-directional sensor with suitable range for expected input, and temperature compensated.
1. Direct acting.
2. 2 percent full scale with repeatability of 0.5 percent.
3. 4 to 20 mA.
4. Range: 0 to 0.25 inch wg.
5. Range: 0 to 5 inch wg.
6. Acceptable Manufacturers:
   a. Honeywell Controls
   b. Johnson Controls
   c. Veris
   d. Setra.
   e. Engineer approved equal

M. Pressure Transducers, Static - Fluid (SPT-F): Stainless steel diaphragm construction, suitable for service; minimum 150 psig operating pressure and tested to 300 psig; linear output 4 to 20 mA. Range suitable for system; linear output 4 to 20 mA.
1. Acceptable Manufacturers:
   a. Honeywell Controls
   b. Johnson Controls
   c. Veris
   d. Setra.
   e. Engineer approved equal

N. Pressure Safety Switch (PS-S): Pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120 VAC.
1. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
2. Acceptable manufacturers
   a. Honeywell Controls
   b. Johnson Controls
   c. Cleveland Controls
   d. or Engineer approved equal.

O. Relative Humidity Transmitter - Room (RH-W): Room Relative Humidity sensors shall be thin film capacitive type sensor device loop or external 12 to 30 VDC powered. The Room Relative Humidity sensor shall provide continuous measurement of the room and output a proportional 0 to 10 VDC or 4 to 20 mA signal within the linear range of 20 to 90 percent RH with an accuracy of two (2) percent.
1. Acceptable Manufacturers:
   a. Honeywell Controls
   b. Johnson Controls
   c. Engineer approved equal

P. Relative Humidity Transmitter – Duct (RH-D): The duct humidity transmitter sensors shall be provided with a sampling chamber. Shall be capable of providing continuous measurement of

percent relative humidity with an accuracy of plus 2 percent over the range 20 to 90 percent RH. The sensor shall be either loop or external 12 to 30 VDC powered. The sensor shall provide an output that is proportional (0 to 10 VDC or 4 to 20 Ma) within the linear range. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket

1. Acceptable Manufacturers:
    a. Honeywell Controls
    b. Johnson Controls
    c. Engineer approved equal

Q. Relative Humidity Transmitter - Outside (RH-O): The Outside Relative Humidity sensors shall be thin film capacitive type sensor device loop or external 12 to 30 VDC powered. The Outside Relative Humidity sensor shall provide continuous measurement of the room and output a proportional 0 to 10 VDC or 4 to 20 mA signal within the linear range of 20 to 90 percent RH with an accuracy of two (2) percent. The Outside Relative Humidity sensors shall be installed with a rain proof, perforated cover. The transmitter components shall be installed in a NEMA-3R enclosure with sealtite fittings and stainless steel bushings.

1. Acceptable Manufacturers:
    a. Honeywell Controls
    b. Johnson Controls
    c. Engineer approved equal

R. Temperature sensor – Wall (TS-W): Wall mounted Temperature sensors shall be provided as shown on project plans, or where temperature control is required for the equipment. Wall mounted Temperature sensors shall have a decorative cover provided for surface or wall box mounting. A metal ventilated plate type cover shall be provided, where conditions indicate damage is most likely to occur. Wall mounted Temperature sensors shall have a range of 30 to 90 degrees F, with an accuracy of plus or minus 0.5 degrees F.

1. Acceptable sensor types are:
    a. 1000 ohm nickel thermistor
    b. 1000 ohm platinum thermistor.
    c. 20K ohm thermistor
2. Where local adjustment are required, an LCD display with four button keypad shall provide the following capabilities:
    a. Display room and outside air temperatures.
    b. Display and adjust room comfort setpoint.
    c. Display and adjust fan operation status.
    d. Timed override request push button with LED status
    e. Display controller mode.
    f. Password selectable adjustment of setpoint and override modes.
    g. A communication port.
3. Acceptable Manufacturers:
    a. Honeywell Controls
    b. Johnson Controls
    c. Engineer approved equal

S. Temperature sensor – Duct Averaging (TS-A): For ducts greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12 foot long segment. Capillary supports at the sides of the duct shall be provided to support the sensing string. Duct Averaging Type Temperature Transmitter shall be a general

purpose RTD sensing element, moisture resistant transmitter for mounting into a duct. The operating range shall be as indicated with an accuracy of plus 1 percent over the full range. The output shall be compatible with the panel it serves. Transmitter shall be with 17 feet of sensor capillary.

1. Manufacturers:
    a. Honeywell Controls
    b. Johnson Controls
    c. Engineer approved equal
    d. Setra.

T. Temperature sensor - Duct Probe (TS-D): Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate. Duct Type Temperature sensor shall be 20K ohm thermistor temperature sensors with an accuracy of plus or minus ; 0.5 degrees F, moisture resistant for mounting into a duct. Duct mounted sensors shall have an insertion measuring probe of a length appropriate for the duct size, with a temperature range of minus 40 to 160 degrees F. The operating range shall be as indicated with an accuracy of plus 1 percent over the full range. The output shall be compatible with the panel it serves.

1. Acceptable Manufacturers:
    a. Honeywell Controls
    b. Johnson Controls
    c. Engineer approved equal

U. Temperature sensor - Immersion (TS-I): Immersion Temperature sensor shall contain an 20K ohm thermistor to monitor water temperature.

1. Acceptable Manufacturers:
    a. Honeywell Controls
    b. Johnson Controls
    c. Engineer approved equal

V. Temperature sensor - Outside Air (TS-O): Outdoor Air Temperature Transmitter shall contain a 20K ohm thermistor temperature sensors with an accuracy of plus or minus ; 0.5 degrees F mounted in an enclosure rated for outdoor use. A solar shield shall be provided for each sensor. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element. These devices shall have accuracy of plus or minus 0.5 degrees F over the entire range.

1. Acceptable Manufacturers:
    a. Honeywell Controls
    b. Johnson Controls
    c. Engineer approved equal

W. Smoke Detectors (SDD): Smoke duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. The Division 26 Electrical contractor shall provide connection to the fire alarm system. The BMS contractor shall provide any control wiring required by the Building Management System.

6.17 SYSTEM OUTPUT CONTROLLED DEVICES

A. Actuators, Control Damper (M): The control damper actuator shall be sized for sufficient force to operate the damper under normal conditions and sized for torque required to guarantee tight close off of dampers, as specified. Two position control damper actuators shall provide auxiliary end-switch . Control damper actuators shall be electronic, 24 VAC or 120 VAC, as selected by the contractor and have internal electronic overload protection or digital rotation sensing circuitry. Modulating control damper actuators shall be controlled from a 2 to 10 VDC or 4 to 20

mA. VAV control damper actuators shall be "drive open; drive closed" type. Control damper actuators shall be selected for specified control (modulating or two position) and Fail Safe position, spring return mechanism, as specified. Control damper actuator coupling shall be by a V bolt and V shaped; toothed cradle designed for minimum 60,000 full stroke cycles at rated torque. The control damper actuator run time for a commanded full stroke operation shall not exceed 120 seconds, if the actuator is spring returned, a return to the failsafe position shall take no longer than 10 seconds closed. Provide external, manual gear release on non-spring return actuators. Control damper actuator casings shall be made of die cast metal. Control damper actuators shall have position indication. Control damper actuators exposed to low temperatures shall have a crankcase heater. Control damper actuator enclosures shall be rated for the mounting environment Pneumatic control damper actuators pilot positioners shall be installed to ensure positioning. Control dampers actuators shall be selected for running torque calculated as follows:

1. 4 inch-lb. /sq. ft. of damper.
2. 7 inch-lb. /sq. ft. of damper.
3. 3 inch-lb. /sq. ft. of damper.
4. 5 inch-lb. /sq. ft. of damper.
5. Additional damper actuator torque calculation per square foot damper surface area:
    a. Add 1.5 inch-lb
    b. Add 2.0 inch-lb
    c. Add 1.5 inch-lb
    d. Add 2.0 inch-lb
6. Acceptable Manufacturers:
    a. Honeywell Controls
    b. Johnson Controls
    c. Belimo Aircontrols (USA), Inc.
    d. Engineer Approved Equal

B. Actuators, Control Valve (M):

1. Actuator sizing: The control valve actuator shall be sized for sufficient force to operate the valve under all conditions and sized for torque required to guarantee tight close off of valves, as specified, against system differential pressure encountered. Two way control valve actuators shall provide a close off rating exceeding the maximum pressure difference between the valve outlet and inlet.
2. Dual Actuators: Control valve actuators shall be capable of being mechanically and electrically paralleled to increase torque, if required. Greater torque or higher close off requirements may be assembled with multiple low torque actuators. Dual mounted control valve actuators using additional anti-rotation strap mechanical linkages or special factory wiring to function are not acceptable. Control valve actuators used in a paired assembly shall be use standard components.
3. Power Requirements: Actuators shall be electronic, 24 VAC or 120 VAC, class 2 as directed by the application, and as selected by the contractor. Actuators shall have internal electronic overload protection or digital rotation sensing circuitry. End switches to deactivate at the end of rotation or magnetic clutches are not acceptable. Power consumption shall not exceed 10 VA for AC.
4. Modulating Control Signal: Spring return actuators shall be capable of CW or CCW mounting orientation. Actuators shall be controlled from a 2 to 10 VDC or 4 to 20 mA. Actuators for VAV applications shall be "drive open; drive closed" type. Pneumatic control valve actuators shall have pilot positioners installed.
5. Noise Generation: Spring return actuators shall not produce more than 62 dbA when powered or positioning. Non-spring return actuators shall have a maximum noise rating of 45 dbA with power on or in the running or driving mode.

6. Fail Safe Operation: Spring return actuators shall be selected for modulating or two position, with a Fail Safe position, as specified. Spring return actuators shall upon a loss of control signal, fail to the minimum control signal. Non-spring return actuator shall maintain the last position upon loss of power. Control valve actuators using “on-board” capacitors or other non-mechanical forms of fail-safe operation are unacceptable.
7. Coupling: Control valve actuators shall be of a Direct coupled type designed for minimum 60,000 full stroke cycles at rated torque.
8. Operation Time: The run time for full stroke operation shall not exceed 120 seconds. Spring return to the failsafe position shall take no longer than 10 seconds closed. Non-spring return actuators greater than 60 in-lb of torque shall have a local external, manual gear release.
9. Construction: Control valve actuator casings shall be made of die cast metal.
10. Position Indication: Actuators on valves larger than 2 inch shall have a visual position indication. When required by the control sequence, two sets of DPDT switches with fully adjustable setpoints shall be provided.
11. Environment Rating: Actuator enclosures shall be rated for the mounting environment Actuators shall have an operating range of minus 22 to 122 degrees F. Actuators exposed to low temperatures shall have a crankcase heater.
12. Acceptable Manufacturers:
    a. Honeywell Controls
    b. Johnson Controls
    c. Belimo Aircontrols (USA), Inc.
    d. Engineer Approved Equal

C. Relays – Pilot (R): Pilot Control relays shall provide either momentary or maintained switching action as appropriate for the application. Relay contact configuration, amp, voltage, and coil ratings shall be suitable for application. All control relays shall be labeled with UR symbol and UL listed. All panel mounted control relays shall be plugged in type with an interchangeable module (Ice Cube); mounted on a subbase and wired to numbered terminals strips; be DPDT with indicating lamp. Remotely mounted pilot control relays (outside of the panel) shall be enclosed in a NEMA enclosure suitable for the location. RIB style relays shall be acceptable for remote control.
   1. Acceptable Manufacturers:
      a. Functional Devices
      b. Veris
      c. IDEC
      d. Engineer approved equal.

6.18 FIELD DEVICES

A. Control Valves
   1. General:
      a. Control valves shall be factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
      b. The control valve nominal body rating shall be not less than 125 PSI.
      c. Control valve body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule in this specification.
      d. The control valves shall be sized by the contractor to produce the required flow capacity at a pressure loss not exceeding the allowable pressure drop.
      e. The control valve body and packing selected shall be sized to withstand the system static head plus the pump head, and the temperatures of the control medium.

f. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved.
g. Flow Characteristics: Two way valves shall have equal percentage characteristics; Three way valves shall have linear characteristics.
h. Connections: Control valve sizes up to, including 2 inch shall be "screwed" configuration. Control valve sizes 2 1/2 inch and larger shall be "flanged" configuration.

2. Control Valve Selection and Sizing Guidelines:
   a. 2-way or 3-way control valves serving Variable Air Equipment coils, shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI.
   b. 3-way control valves serving Constant Air Equipment coils, with secondary loop pumps shall be sized for a pressure drop equal to 25 percent of the actual coil pressure drop, but no less than 2 PSI.
   c. 3-way mixing control valves serving secondary water loops shall be sized for a pressure drop of no less than 5 PSI.
   d. All control valve sizes less than 2 inches shall be globe valves.
   e. Control valves for terminal reheat coils shall be sized for no less than a 2 PSIG pressure drop, but no more than a 5 PSI drop.
   f. Ball Valves (w/characterized disk) shall be used for hot and chilled water applications, water terminal reheats coils, radiant panels, unit heaters, package air conditioning units, and fan coil units.
   g. Hot water control valves shall fail Normally Open to the coil.
   h. Chilled water control valves shall be fail Normally Closed to the coil.
   i. Steam control valves shall fail Normally Closed to the coil or as stated in the sequences.
3. Modulating plug valves: Single seat type Equal percentage shall be used for approved applications. Valve discs shall be composition type. Valve stems shall be stainless steel.
4. Globe Valves:
   a. NPS 2 inch and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with back seating capacity repackable under pressure.
   b. NPS 2 1/2 inch and Larger: Class 125 iron body, bronze trim, rising stem, plug type disc, flanged ends, and renewable seat and disc.
   c. Internal Construction: Replaceable plugs and stainless steel or brass seats.
   d. Single Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
   e. Double Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
   f. Control valve sizing: 3 psig pressure drop at design flow rate or the following:
      1) Two or Three Way, two position: Line size.
      2) Two Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
      3) Three Way Modulating: Twice the load pressure drop, but not more than value specified above.
   g. Valve Flow Characteristics: Two way valves shall have equal percentage characteristics. Three way valves shall have linear characteristics.
   h. Close Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum of 150 percent of pump head for two way valves; 100 percent of pressure differential across valve or 100 percent of pump head.
   i. Low Pressure Steam Globe valves shall have the following characteristics:

1) NPS 2 inch and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with back seating capacity repackable under pressure.
2) NPS 2 1/2 inch and Larger: 7Class 125 iron body, bronze trim, rising stem, plug type disc, flanged ends, and renewable seat and disc.
3) Internal Construction: Replaceable plugs and stainless steel seats.
4) Single Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
5) Double Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
6) Sizing:
   (a) For pressure drop based on the following services:
   (b) 20 percent of inlet pressure.
   (c) 15 psig Steam: 80 percent of inlet pressure.
   (d) 16 to 50 psig Steam: 50 percent of inlet pressure.
   (e) > 50 psig Steam: As indicated.
7) Flow Characteristics: Modified linear characteristics.
8) Close Off Pressure Rating: 150 percent of inlet pressure.

j. Acceptable Manufacturers:
1) Honeywell, Belimo Controls (USA), Inc.
2) Engineer Approved equal.

5. Butterfly Valves:
a. Butterfly control valves shall be acceptable for the following applications:
1) Modulating large flow applications greater than modulating plug valves
2) All two position, open/close applications for isolation requirements as shown on the drawings or required herein.
b. Butterfly control valves shall have the following features:
1) A manual override hand wheels for operating the valve.
2) Butterfly control valve body ratings in accordance with the piping specifications.
3) An external position indication.
4) Speed control device to prevent rapid closure.
5) Replaceable lining suitable for temperature of system.
6) Valves in the closed position shall be bubble tight.
7) Butterfly control valve materials:
   (a) ASTM A 126 cast iron or ASTM A 536 ductile iron body and bonnet, extended neck.
   (b) Stainless steel stem.
   (c) EPDM or Buna N sleeve and stem seals.
8) Valves shall be high performance:
   (a) ANSI 150/300 Carbon steel body.
   (b) 316 stainless steel disc and stem shaft
   (c) Reinforced Teflon seat and seals.
   (d) Body Style: Fully lugged.
   (e) Disc Type: Nickel plated ductile iron, Aluminum bronze, Elastomer coated ductile iron, Epoxy coated ductile iron.

c. Butterfly Valve Sizing
1) Two position: The Butterfly valves shall be line size as shown on plans
2) Modulating: 3 psig maximum pressure drop at design flow rate. Sized and travel limited to 60 degrees of full open.

d. Acceptable Manufacturers:

1) Honeywell
2) Belimo Controls (USA), Inc.
3) Bray
4) or Engineer approved equal.

B. Control Valves - Terminal Units:
1. Control Valve Materials & Features:
a. Hot Water valves shall have Bronze body & trim
b. Low Pressure Steam (LPS) control valves shall have Bronze body & stainless steel trim.
c. Control valves shall be either 2 or 3 way ports as indicated, replaceable plugs and seats, and union and threaded ends.
2. Class 125 for service at 125 psig and 250 degrees F operating conditions.
3. Control Valve Sizing: 3 psig maximum pressure drop at design flow rate
4. Control valve actuator shall be sized to close against pump shutoff head.
5. Acceptable Manufacturers:
a. Honeywell Controls
b. Belimo Controls (USA)
c. or pre-approved equal.

C. Dampers, Fire/Smoke (FSM or FSD) and Smoke Dampers (FBO - Reference Only): Dampers shown on drawings which are designated as “F/SM” or “F/SD”. Combination Fire and Smoke Dampers shall be electrically operated provided with factory installed U.L. rated full sleeves. Combination Fire and Smoke Dampers shall be air foil or “V” blade damper blades supported with shafts and stainless steel bearings to allow daily operation. Combination Fire and Smoke damper blades more than 36 inch long shall have intermediate supports and bearings. A U.L. label shall be affixed to each assembly and conform to UL Standard 555 and 555S as leakage rated dampers in smoke control systems when closed shall be the equivalent of a 1 1/2 hour fire damper. Leakage shall conform to Class 2 with maximum leakage of 10 CFM/Sq. Ft. at 1 inch W.G. Combination Fire and Smoke Damper actuators shall be provided with position indicator switches to enable remote status of open or closed positions (only those dampers designated in the electrical trade plans and specifications shall be provided with position switches and shall be wired for remote status and remote open/closed operation, but all dampers shall be provided with position indicators for possible future use). Combination Fire and Smoke dampers which are controlled from a central fire command station shall be provided with a 212 degrees F heat sensor with normally closed contacts (manual reset) to close and lock damper if open. Additionally, dampers shall be factory equipped with a second normally closed heat sensor correlating to the operator/actuator degradation temperature classification (250 to 350 degrees F, depending on actuator utilized). The second sensor is wired through a manual override switch on the central fire command station. Dampers which are not controlled from a central fire command station shall have a fusible link which melts on heat causing damper to close and lock in a closed position. The following shall be accepted in lieu of the two firestats described. A resettable bimetallic link which opens on heat permitting damper to close and lock if open. This link may be re-engaged from fire command station at temperature of 150 degrees F or less. Dampers shown on drawings designated “SM” shall comply in all respects to F/S damper description including position indicating switches except they shall not be provided with a heat sensor or fusible link.

D. System Integration - Fire Alarm: The Fire Alarm Annunciating and Indication System shall be UL864 listed under Category (UOJZ) as a proprietary fire alarm unit. This system shall be responsible for the primary indication and annunciation of all fire alarm conditions. For those points indicated on the plans, a hardwired contact output shall be provided by the Division 26 Fire Alarm Contractor to the BMS system as an input signal. The BMS system shall use these

input signals for control of air handling systems, dampers and other sequences as specified by the Engineer for Smoke Control. Additionally, the status of these points shall be displayed on the appropriate color-graphic display.

E. Transformers - Control Power (XT): Control power transformers shall be UL listed, Class 2 current limiting type, or shall be furnished with over current protection with primary and secondary circuits for Class 2 service. Unit power output shall match the required output current and voltage requirements. Current output shall allow for a 50 percent safety factor. Output ripple shall be 3.0 mV maximum Peak to Peak. Regulation shall be 0 to 10 percent line and load combined, with 50 microsecond response time for 50 percent load changes. Unit shall have built in over voltage protection. Unit shall operate between 32 to 120 degrees F. Unit shall be UL recognized.
   1. Acceptable Manufacturers:
      a. Honeywell Controls
      b. Functional Devices
      c. Engineer approved equal.

F. Thermowells, Immersion: Thermowells shall be provided by the BMS contractor. The thermowells shall be of sufficient size for the pipe in which it is to be installed. The Thermowells shall be pressure rated and constructed for the system working pressure. The Thermowells shall be mounted in a threadolet or 1/2 inch NPT saddle. The Thermowells shall be constructed of 316 stainless steel or as approved by the engineer.
   1. Manufacturers:
      a. Honeywell Controls
      b. Johnson Controls
      c. Engineer approved equal

G. Tamper or Vandal Resistant Covers: Provide the required tamper resistant or vandal resistant enclosures/covers for protection of thermostats, sensors, or other control devices in areas where tampering or vandalism may occur. The enclosures/covers shall be designed to withstand tampering or damage and abuse common in many public access spaces and other areas. Where applicable, enclosures/covers shall have tamper proof socket head screws.

H. Enclosures and Local Control Panels: All enclosures shall be rated for the mounted environment. Unless otherwise shown, all indoor control enclosure cabinets shall be fully enclosed NEMA 1 steel construction, with a baked enamel finish. A hinged door key lock latch and removable sub panels shall be provided for non-unitary equipment. A single key shall be common to all field panels and sub panels. Interconnections between internal and face mounted devices shall be prewired 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. Provide ON/OFF power switch with over current protection for control power sources to each local panel. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers. All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carries a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch. In general, the control panels shall consist of the BACnet DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted. All I/O connections on the BACnet DDC controller shall be provide via removable or fixed screw terminals. Low and line voltage wiring shall be

segregated. All provided terminal strips and wiring shall be UL listed 300 volt service and provide adequate clearance for field wiring. All wiring shall be neatly installed in plastic trays or tie wrapped. Control Panels shall be rated for the environment in which they are located.

1. Acceptable manufacturers
    a. Honeywell Controls
    b. or pre-approved equal.

I. BMS Control Cabling: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 26 unless otherwise noted herein. All insulated wire to be copper conductors, UL labeled for 90 degrees C minimum service. Electronic and fiber optic cables for control wiring are specified in Electrical Section "Voice and Data Communication Cabling."

1. Communication and Control Wiring: Wire Sizing and Insulation shall comply with minimum wire size and insulation based on services listed below:
2. Minimum Gage/Type Insulation Class
    a. Power 12 Ga Solid 600 Volt
    b. Power 10 Ga Solid 600 Volt
    c. 14 Ga Stranded 600 Volt
    d. 18 Ga Stranded 300 Volt
    e. 18 Ga Stranded 300 Volt
    f. Open plenum rated cable is permitted in supply or return air plenum where allowed.
3. Power Wiring:
    a. 115 VAC power circuit wiring > 100 feet distance shall use minimum 10 gage.
    b. 24 VAC control power wiring > 200 feet distance shall use minimum 12 gage.
4. Control Wiring:
    a. Digital Input/Output wiring shall use Class 2 twisted pair, insulated.
    b. Analog inputs shall use Class 2 twisted shielded pair, insulated, and jacketed and require a grounded shield.
5. Communication Wiring:
    a. Ethernet Cable shall be minimum CAT5e minimum
    b. Secondary level network shall be 24 gage, TSP, low capacitance cable
6. Approved Cable Manufacturers:
    a. Anixter
    b. Belden

PART 1 EXECUTION

7.01 OVERVIEW

A. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.

B. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by the Control System Contractor in accordance with these specifications.

C. Equipment furnished by the Mechanical Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field shall be furnished and installed by the Control System Contractor.

D. All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic labels.

7.02 BMS SPECIFIC REQUIREMENTS

A. Graphic Displays

1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection.

B. End Device Actuation
1. All damper and valve actuation shall be DDC electronic.
2. Controls shall be provided by the BMS manufacturer as specified herein.

C. Control Type
1. Air Handling Equipment
a. Controls shall be provided by the BMS manufacturer as specified herein.
b. Controlled with a BACnet DDC Controller
2. Terminal Equipment (VAV, UV, etc.)
a. Controls shall be provided by the BMS manufacturer as specified herein.
b. Controlled with a BACnet DDC Controller

7.03 EXAMINATION

A. Conditioned Power
1. Verify that conditioned power supply is available to the operator workstation.

B. Emergency Power
1. Verify that emergency power supply is connected to panels designated as such.

7.04 CODE COMPLIANCE

A. NEC compliance:
1. All wiring shall be installed in accordance with all applicable electrical codes and shall comply with equipment manufacturer's recommendations. Should any discrepancy be found between wiring specifications in this section and Electrical sections, the stricter wiring requirements shall prevail.

7.05 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. All electrical control wiring to the control panels shall be the responsibility of the BMS contractor.

B. All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes.

C. Control wiring shall be of adequate length for the installation. Excess wire shall not be looped or coiled in the controller cabinet.

D. Use approved optical isolation and lightning protection when penetrating building envelope.

E. Read installation instructions carefully. Any unavoidable deviations shall be approved by owner's rep prior to installation.

F. Component Installation references:
1. Install raceways, boxes, and cabinets according to Electrical Section "Raceways and Boxes."
2. Install building wire and cable according to Electrical Section "Conductors and Cables."
3. Install signal and communication cable according to Electrical Section "Voice and Data Communication Cabling."
4. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
5. Install exposed cable in raceway.
6. Install concealed cable in raceway or use plenum cable installed in workmanlike fashion.

7. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
8. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
9. Number code or color code conductors for future identification and service of control system, except local individual room control cables.
10. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
11. All wire shall be copper and meet the minimum wire size and insulation class listed below:

G. Power Wiring:
1. 120 VAC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 26.
2. BMS power circuits shall be dedicated to the BMS devices and shall not be used for any other purposes.
3. BACnet DDC terminal unit controllers may use power from the equipment power circuits.
4. All NEC Class 1 (line voltage) wiring shall be UL Listed and installed approved conduit according to NEC and Division 26 requirements.
5. Power wiring must meet NEC / Local standards; minimum 12 gauge, stranded, THHN
6. Power and Class One wiring may be run in the same conduit.
7. Power Wiring must be in ¾ inch EMT where concealed or exposed.
8. Where different wiring classes terminate within the same enclosure, maintain clearances, and install barriers per the National Electric Code.

H. BMS Raceway
1. Conduit Raceway
   a. All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 26 Electrical.
   b. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification.
   c. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
   d. Include one pull string in each conduit 3/4 in. or larger.
   e. All wiring in mechanical, electrical, or service rooms—or where subject to mechanical damage— shall be installed in conduit.
   f. Conceal all conduit, except within mechanical, electrical, or service rooms.
   g. Conduit in finished areas shall be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction.
   h. Exposed conduit shall run parallel to or at right angles to the building structure.
   i. Install conduit to maintain a minimum clearance of 6 in. from high temperature equipment (e.g., steam pipes or flues).
   j. Class 2 and 3 wiring and communications wiring may be run in the same conduit.
   k. Support: Secure conduit with conduit clamps fastened to the structure and spaced according to code requirements. Conduit and pull boxes shall not be hung on flexible duct strap or tie rods. Conduits shall not be run on or attached to ductwork
   l. Couplings and Terminations: Conduit sections shall be joined with couplings (according to code). Conduit section terminations shall be made with fittings at boxes, as needed. Conduit section terminations not ending in boxes shall have bushings installed.

m. Class Separation: Where different wiring classes terminate within the same enclosure, maintain clearances, and install barriers per the National Electric Code.
n. Dry locations: Set screw fittings are acceptable for dry interior locations.
o. Exterior & High Moisture Prone Locations: Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit sealoff fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.
p. Flexible metallic conduit: Flexible metallic conduit shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Flexible metal conduits shall not exceed 3 feet in length and shall be supported at each end. Minimum Flexible metal conduit is ½ inch. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed. Liquid tight flexible conduit shall be use in exterior locations and interior locations subject to moisture, including chiller and boiler rooms, liquid tight, flexible metal conduits shall be used.
q. Surface Raceway: Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect. Metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
r. Conduit and Raceway Sizing: The sizing, type and provision of conduit and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the BMS Contractor shall be responsible for all costs incurred in replacing the selected components.
s. Expansion Joints: Adhere to this specification's Division 26 requirement where conduit crosses building expansion joints.
t. Junction Boxes: Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers. ¨

I. BMS Control Wiring
1. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section. All wiring shall be run in conduit as specified in Division 26.
2. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings.
   a. EXCEPTION: Any wire run in suspended ceilings that is used to monitor critical life safety systems or control critical equipment shall be in conduit.
3. Control wire shall be plenum rated stranded #18 gauge with minimum 300 VAC insulation.
4. Input wiring shall be shielded & fire rated Teflon jacketed where concealed but accessible.
5. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.
6. Wire shall not be allowed to run across telephone equipment areas.
7. All control and interlock wiring shall comply with national and local electrical codes and Division 26 of this specification. Where the requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.
8. Where the wires leave the conduit system, they shall be protected by a plastic insert.
9. Class 2 Wiring: All low voltage wiring shall meet NEC Class 2 requirements. (Low voltage power circuits shall be sub fused when required to meet Class 2 current limit.). Class 2

signal wiring and 24 VAC power can be run in the same conduit. Do not install Class 2 wiring in conduit containing Class 1 wiring or tubing. Boxes and panels containing high voltage wiring and equipment may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers). Where Class 2 wires are in concealed and in accessible locations, including ceiling return air plenums, approved cables not in conduit may be used provided that cables are UL Listed for the intended application.

10. Installation: Wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 10 feet intervals.
11. Cable Support: Plenum rated cable shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical conduits, piping, or ceiling suspension systems.
12. Wiring Device Terminations: All wire-to-device connections shall be made at a terminal block or wire nut. All wire-to-wire connections shall be at a terminal strip or wire nut. Exposed terminations shall not be acceptable. Terminations shall be contained within either the device or local junction box. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
13. No Splices: All plenum rated wiring shall be installed as continuous lengths, with no splices permitted between termination points. All wiring in conduit shall be installed as continuous lengths, with no splices permitted between termination points or junction boxes.
14. Grounding: Provide for complete grounding of all applicable signal and communications cables, panels, and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

J. BACnet Communication Wiring: The BMS contractor shall adhere to the items listed in the "BMS Wiring" article in Part 3 of the specification. All cabling shall be installed in a neat and workmanlike manner. Do not install communication wiring in conduit or raceway containing Class 1 or other Class 2 wiring. The Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation. The BMS Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
    1. Labeling: All communication wiring shall be labeled to indicate origination and destination data.
    2. No Splicing: All runs of communication wiring shall be unspliced length when that length is commercially available.
    3. Grounding: Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding". When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to the manufacturer's instructions.

K. Wall and Floor Penetrations: Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

L. BMS Identification Standards: All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location. Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

7.06 FIELD DEVICE INSTALLATION

A. General: Locate components of the BMS in accessible local control panels wherever possible. All Input devices shall be installed per the device manufacturer recommendation. The mechanical contractor shall install all mechanical devices i.e. control valves, dampers, temperature wells, pressure taps, airflow stations, etc.…

B. Enclosures: The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations. The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors. For all I/O requiring field interface devices, these devices where practical shall be mounted in a Field Interface Panel (FIP). The BMS Contractor shall provide an enclosure, which protects the device(s) from dust, moisture, conceals integral wiring and moving parts. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. The enclosure shall be sized for twenty percent spare mounting space. All locks shall be keyed identically. All wiring to and from the FIP shall be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited. All outside mounted enclosures shall meet the NEMA-4 rating. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

C. Damper Actuators: Shall be firmly mounted to give positive movement and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the stroke.

D. Immersion Wells: Well mounted sensors shall include thermal conducting compound within the well to insure good heat transfer to the sensor. Water line mounted sensors shall be removable without shutting down the system in which they are installed.

E. Low Temperature Limit Switches (LLS): Install on the discharge side of the first water or steam coil in the air stream. Mount element horizontally across duct in a serpentine pattern ensuring each square foot of coil is protected by 1 foot of sensor. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.

F. Pressure sensors, Air - Building static: The high pressure port shall be inserted into the space via a metal tube. The low pressure port shall be piped to the outside of the building. Transmitter's exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind. The interior tip shall be inconspicuous and located as shown on the drawings.

G. Pressure sensors, Air - Duct static: The high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.

H. Pressure sensors, Differential - Water: Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device. Differential pressure transmitters shall be supplied with tee fittings and shut off valves in the high and low sensing pickup lines. Air bleed units, bypass valves and compression fittings shall be provided. Transmitters shall be installed in an accessible location wherever possible.

I. Pressure, Differential Switches – Air: Install with static pressure tips, tubing, fittings, and air filter.

J. Pressure, Differential Status Switches – Water: The mechanical contractor shall install the device with shut off valves for isolation.

K. Relay Outputs: Transient suppression shall be provided across all coils. Suppression devices shall limit transients to 150 percent of the rated coil voltage.

L. Space Sensors: Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor or per ADA requirements. Provide lockable tamper proof covers in public areas and/or where indicated on the plans.

M. Temperature sensors - Duct: Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor. The sensor shall be mounted to suitable supports using factory approved element holders.

N. Temperature sensors - Outside Air: Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately. Sensors shall be installed with a rain proof, perforated cover.

7.07 OUTPUT DEVICE INSTALLATION

A. General: All output devices shall be installed per the manufacturer's recommendation. The mechanical contractor shall install all inline devices such as control valves, dampers, airflow stations, pressure wells, etc.

B. Actuators: All control actuators shall be sized capable of closing against the maximum system shut off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.

C. Control Dampers: Opposed blade dampers shall be installed for modulating control of airflow. Parallel blade dampers shall be installed for two position applications. Damper actuators shall be installed on the outside of duct in warm areas, not in locations exposed to outdoor temperatures.

D. Control Valves: Control Valves shall be sized for proper flow control.

7.08 OPERATOR WORKSTATIONS

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

7.09 CLEANING

A. The contractor shall clean up all debris resulting from their activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

7.10 IDENTIFICATION

A. Cables: Identify all control wires with labeling tape or sleeves using either words, letters, or numbers that can be exactly cross referenced with asbuilt drawings.

B. Enclosures: All field enclosures, other than controllers, shall be identified with a bakelite nameplate. The lettering shall be in white against a black or blue background.

C. Junction Boxes: Junction box covers shall be marked to indicate that they are a part of the BAS system.

D. Field Devices: All I/O field devices (except space sensors) that are not mounted within FIPs shall be identified with name plates. All I/O field devices inside FIPs shall be labeled.

7.11 DEVICE LOCATIONS

A. Project Drawings: The location of sensors is per mechanical and architectural drawings.

B. Space Sensors: Space humidity or temperature sensors shall be mounted away from machinery generating heat, direct light, and diffuser air streams.

C. Outside Air Conditions: Outdoor air sensors shall be mounted on the northerly facing directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.

D. Enclosures: Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

7.12 SYSTEM TESTING

A. Upon completion of the control device installation, the BMS contractor shall load all system software and startup the system. The BMS contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning in full accordance with these specifications.

B. Manufacturer's Field Service: A directly employed factory authorized & trained service technician shall inspect, test, and adjust field assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

C. Expertise: The BMS shall be set up and checked by factory trained competent technicians skilled in the setting and adjustment of the BMS/DDC equipment used in this project. These technicians are to be experienced in the type of HVAC systems associated with this project. The BMS contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100 percent of the input and output points of the DDC system operation.

D. Point-to-Point Checkout: Each I/O device (both field mounted as well as those located in field interface panels) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated, and approved by the BMS contractor for submission to the owner or owner’s representative.

E. Controller and Workstation Checkout: A field checkout of all controllers and front end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner’s representative by the completion of the project. All approved submitted sequences shall be tested by the control contractor before acceptance testing described below.

F. Control Device Verification: Verify that instruments are installed before calibration, testing, and loop or leak checks. Check instruments for proper location and accessibility. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations. Check flow instruments. Inspect tag number and line and bore size and verify that inlet side is identified and that meters are installed correctly. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators. Check temperature instruments and material and length of sensing elements. Check control valves. Verify that they are in correct direction. Check DDC system as follows:
   1. Verify that DDC controller power supply is from emergency power supply, if applicable.
   2. Verify that wires at control panels are tagged with their service designation and approved tagging system.
   3. Verify that spare I/O capacity has been provided.

4. Verify that DDC controllers are protected from power supply surges.
5. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

G. Calibrating and Adjusting
1. Initial Setpoints: Adjust initial temperature and humidity set points.
2. Calibrate instruments: Make three point calibration test for both linearity and accuracy for each analog instrument. 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.
3. Control System Inputs and Outputs: Check analog inputs at 0, 50, and 100 percent of span. Check analog outputs using milliampere meter at 0, 50, and 100 percent output. Check digital inputs using jumper wire. Check digital outputs using ohmmeter to test for contact making or breaking.
4. Flow: Set differential pressure flow transmitters for 0 and 100 percent values with 3 point calibration accomplished at 50, 90, and 100 percent of span. Manually operate flow switches to verify that they make or break contact.
5. Pressure: Calibrate pressure transmitters at 0, 50, and 100 percent of span. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
6. Temperatures: Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision resistance source. Calibrate temperature switches to make or break contacts.
7. Dampers and Valves: 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. 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.

H. Provide diagnostic and test instruments for calibration and adjustment of system.

I. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

J. The BMS acceptance shall be contingent upon completion and review of all corrected deficiencies. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, “Submittals.”

K. All application software shall be verified and compared against the sequences of operation. Control loops shall be exercised by inducing a setpoint shift of at least 10 percent and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.

L. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.

M. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.

N. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

O. At the completion of the Acceptance Testing, this BMS contractor shall demonstrate the sequence of operations for each system to the Architect or his representative.

7.13 BMS ACCEPTANCE TESTING

A. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, startup, and debugging process and as specified in the “Control System Checkout and Testing” article in Part 3 of this specification. The engineer shall be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.

B. The contractor shall provide at least two persons equipped with two way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, “Occupied”, “Unoccupied”, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.

C. As each control input and output is checked, a log shall be completed showing the date, technician’s initials, and any corrective action taken or needed.

D. BACnet DDC control loop response: The contractor shall supply trend data output in a graphical form showing the step response of each BACnet DDC control loop. The test shall show the loop’s response to a change in set point, which represents a change of actuator position of at least 25 percent of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under damped or over damped control shall require further tuning by the Contractor.

E. Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute by minute basis over at least a 30 minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.

F. Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change of value or change of state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.

G. Interface to the building fire alarm system.

H. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48 hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and electronic formats.

I. Tests and Inspections: Prior to acceptance the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the BMS Contractor has completed the installation, started up the system, and performed his/her own tests.
   1. Perform the following field tests and inspections and prepare test reports:
      a. Operational Test:
      b. After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
      c. Test and adjust controls and safeties.
      d. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

e. Test each point through its full operating range to verify that safety and operating control set points are as required.
f. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
g. Test each system for compliance with sequence of operation.
h. Test software and hardware interlocks.

2. Retesting: Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.
3. Acceptance Check Sheet: Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification. Submit the check sheet to the Engineer for approval. The Engineer shall use the check sheet as the basis for acceptance with the BMS Contractor.

7.14 BMS ACCEPTANCE

A. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.

7.15 BMS OPERATOR TRAINING

A. During system commissioning and at such time acceptable performance of the Control System hardware and software has been established, the BMS contractor shall provide onsite operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software, and accessories.

B. The BMS contractor shall provide 40 total hours of comprehensive training in multiple sessions for system orientation, product maintenance and troubleshooting, programming, and engineering. These classes are to be spread out during the 1st year warranty period. The first class starting after final commissioning and the last class is to be in the last month of 1 year warranty period.

C. Scheduling: Training shall be provided after the system has been commissioned and demonstrated to the Architect or his representative. The BMS contractor shall provide a minimum of 16 hours of onsite training specifically geared to the operation, maintenance, and functionality of the control system. This shall include general HVAC System instructions, control system operation and integration to the HVAC components, programming, operation of graphics through front end software, remote dial up, alarm acknowledgement and other general functions of the Control System. Two (2) - four (4) hour training periods shall be scheduled upon completion but before owner acceptance of the BMS system. An additional two (2) - four (4) hour training periods shall be performed at the start of the second year the BMS has been in operation for a total of sixteen (16) instructional training hours. Additional field or factory training shall be provided, if requested, outside of this contract at the customer’s expense.

D. Training Personnel: A BMS representative who is factory trained and authorized to provide such service shall provide training to the Owner's personnel. The training shall include instruction of the owners’ designated personnel on the operation and maintenance of the entire BMS. This orientation shall, at a minimum, consist of a review of the project asbuilt drawings; the BMS software layout and naming conventions and a walk through of the facility to identify panel and device locations

7.16 WARRANTY

A. Equipment, materials, and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Remote Connectivity: The Owner shall provide all Internet Service Provider services and connections (Full time high speed ISP connection recommended for remote site access (i.e. T1, ADSL, cable modem)) for the BMS Contractor to perform BMS warranty response work. This connection shall be maintained throughout the warranty period at the Owner's cost for remote site warranty access and support. The BMS contractor shall identify the specific connection requirements in a shop drawing submittal.

C. Occupancy Adjustments: When requested by the owner within 12 months of date of Substantial Completion. Provide remote adjustment to the system to suit actual occupied conditions. Provide up to three site visits during normal occupancy hours for this purpose.

D. Material Warranty Repair &/or replacement: Within this period, upon notice by the Owner, any defects in the BMS due to faulty materials, methods of installation or workmanship shall be promptly repaired or replaced by the BMS contractor at no expense to the Owner.

E. Maintenance of Computer Software Programs: The BMS contractor shall maintain all software during the standard first year warranty period. All factory upgrades to software during the first year warranty period shall be added to the systems, when they become available, at no additional cost.

F. Scheduled Maintenance of Control Hardware: The BMS contractor shall inspect, repair, replace, adjust, and calibrate, as required, the controllers, control devices and associated peripheral units during the warranty period. The BMS contractor shall then furnish a report describing the status of the equipment, problem areas (if any) noticed during service work, and description of the corrective actions taken. The report shall clearly certify that all hardware is functioning correctly.

G. Service Period: Non-warranty service calls by the owner shall be addressed within 24 hours. Non-warranty service, replacement or repair are not to be considered as part of routine maintenance.

H. Service Documentation: A copy of the service report associated with each owner initiated service call shall be provided to the owner.

I. BMS System Access: The Owner shall grant to the BMS Contractor reasonable access to the BMS during the warranty period. Remote access to the BMS (for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period) shall be allowed.

7.17 OPERATION & MAINTENANCE MANUALS

A. See Division 1 for requirements. O&M manuals shall include the following elements, as a minimum:
   1. Asbuilt control drawings for all equipment.
   2. Asbuilt Network Communications Diagram.
   3. General description and specifications for all components.
   4. Completed Performance Verification sheets.
   5. Completed Controller Checkout/Calibration Sheets.

7.18 PROTECTION

A. Protect installed products until completion of project.

B. Touch up, repair, or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 23 0934
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.

1.03 RELATED REQUIREMENTS

A. Section 23 0529 - Hangers and Supports for HVAC Piping and Equipment.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0573 - Power System Studies: Additional criteria for selection and adjustment of equipment and associated protective devices specified in this section.

1.04 REFERENCE STANDARDS

A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code).

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. NEMA ICS 6 - Industrial Control and Systems: Enclosures.

D. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives.

E. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems.

F. NEMA ICS 7.2 - Application Guide for AC Adjustable Speed Drive Systems.

G. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems.

H. NEMA MG 1 - Motors and Generators.

I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

J. NFPA 70 - National Electrical Code.

K. UL 508A - UL Standard for Safety Industrial Control Panels .

L. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work to provide motor controllers suitable for use with actual motors to be installed.
   2. Coordinate work to provide controllers and associated wiring suitable for interface with control devices to be installed.
   3. Coordinate arrangement with dimensions and clearance requirements of actual equipment to be installed.
   4. Verify with manufacturer that conductor terminations are suitable for use with conductors to be installed.
   5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.

B. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of controllers and adjacent equipment with required clearances indicated.
   2. Include wiring diagrams showing factory and field connections.

C. Field quality control test reports.

D. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

E. Project Record Documents: Record actual installed locations of controllers and final equipment settings.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
   1. Authorized service facilities located within 100 miles of project site.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.09 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

1.10 WARRANTY

A. Provide minimum 3 year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ABB

B. Danfoss.

C. Yaskawa Electric Corp..

D. Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Controller Assemblies: Comply with NEMA ICS 7, NEMA ICS 7.1, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.

D. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 1 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
   1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 1 design letter or inverter duty rating for induction motors.
   2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
   3. Motor nameplate data.
   4. Requirements for speed control range, speed regulation, and braking.
   5. Motor suitability for bypass starting method, where applicable.

E. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.

F. Operating Requirements:
   1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
   2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
   3. Efficiency: Minimum of 96 percent at full speed and load.
   4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
   5. Overload Rating:
      a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
      b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.

G. Power Conversion System: Microprocessor-based, pulse width modulation type consisting of rectifier/converter, DC bus/link, and inverter.
   1. Rectifier/Converter: Diode-based, 6-pulse type unless otherwise indicated.

H. Control System:
   1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
   2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
   3. Control Functions:
      a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
         1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
         2) Vector Control: Provide selectable autotuning function.
      b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
      c. Selectable braking control; DC injection or flux braking.
      d. Adjustable minimum/maximum speed limits.
      e. Adjustable pulse width modulation switching carrier frequency.
      f. Adjustable motor slip compensation.
      g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
      h. Energy-saving algorithms.

4. Status Indications:
    a. Motor run/stop status.
    b. Motor forward/reverse status.
    c. Local/remote control status.
    d. Output voltage.
    e. Output current.
    f. Output frequency.
    g. DC bus voltage.
    h. Motor speed.
5. Protective Functions/Alarm Indications:
    a. Overcurrent.
    b. Motor overload.
    c. Undervoltage.
    d. Overvoltage.
    e. Controller overtemperature.
    f. Input/output phase loss.
    g. Output short circuit protection.
    h. Output ground fault protection.
6. Inputs:
    a. Digital Input(s): Three.
    b. Analog Input(s): Two.
7. Outputs:
8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
    a. Serial Communications: Support for BACnet MS/TP protocol.
    b. Ethernet Communications: Support for Modbus TCP and BACnet IP protocol.
9. Features:
    a. Password-protected security access.
    b. Event log.

I. Power Conditioning/Filtering:
1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
2. Reactor Impedance: 3 percent, unless otherwise indicated or required.

J. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
1. Disconnects: Circuit breaker or disconnect switch type.
    a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
    b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
    c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
2. Provide door-mounted remote operator interface.
3. Packaged Controllers with Bypass: Provide contactors and controls to enable removal of variable-frequency controller from circuit.
    a. Bypass Method: Manual, unless otherwise indicated.
    b. Bypass Configuration: 3-contactor type, with contactors for bypass, drive output, and drive input.
    c. Bypass Motor Starting Method: Full-voltage (across-the-line) with overload relay, unless otherwise indicated or required.

d. Overload Relays: Solid state or bimetallic thermal type.

4. Pilot Devices Required:
   a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings, except where equivalent function is provided by remote operator interface.
   b. Packaged Controllers with Bypass:
      1) Bypass Mode Selector Switch: DRIVE/OFF/BYPASS.
      2) Motor Control Selector Switch: HAND/OFF/AUTO.
      3) Indicating Lights: For drive/bypass mode status, drive/bypass run status, and drive/bypass fault status.

K. Service Conditions:
   1. Provide controllers and associated components suitable for operation under following service conditions without derating:
      a. Altitude: Less than 3,300 feet.
      b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
   2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.

L. Short Circuit Current Rating:
   1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as determined by short circuit study performed in accordance with Section 26 0573.
   2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.

M. Conductor Terminations: Suitable for use with conductors to be installed.

N. Enclosures:
   1. Comply with NEMA ICS 6.
   2. NEMA 250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
   3. Finish: Manufacturer's standard unless otherwise indicated.
   4. Cooling: Forced air or natural convection as determined by manufacturer.

O. Interface with Other Work:
   1. Provide products compatible with other systems requiring interface with controllers.
   2. Interface with building automation system.
      a. Capable of remote monitoring and control of controllers.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of controllers are consistent with indicated requirements.

C. Verify that mounting surfaces are ready to accept controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.

C. Do not exceed manufacturer's recommended maximum cable length between controller and motor.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required support and attachment in accordance with Section 23 0529.

F. Install controllers plumb and level.

G. Provide grounding and bonding in accordance with Section 26 0526.

H. Install field-installed devices, components, and accessories.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.

C. Packaged Controllers with Bypass: Test for proper operation in both drive and bypass modes.

D. Test for proper interface with other systems.

E. Correct deficiencies and replace damaged or defective controllers or associated components.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.

B. Training: Train Owner's personnel on operation, adjustment, and maintenance of controllers and associated devices.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.07 PROTECTION

A. Protect installed controllers from subsequent construction operations.

END OF SECTION

SECTION 23 0993
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

1.01 PART 1 GENERAL

A. Summary
   1. This Section includes control sequences for HVAC systems, subsystems, & equipment.
   2. Related Sections include the following:
      a. Section 23 09 00 Instrumentation & Control for HVAC for control equipment & devices & for submittal requirements.
      b. Reference the Project drawings, ATC diagrams for Unit configuration, ATC devices, point types & locations

B. Coordinated Sequences & ATC Diagrams
   1. Project ATC Sequences of Operations detailed below are predicated on the generalized control of the HVAC equipment and may require additional modification of the sequences to incorporate the given equipment..Reference the project plans and schedules for the Unit configuration, ATC control devices, point types & locations for each device.
   2. Control Sequence Descriptions: Provide all devices, wiring, controllers, interlocks, accessories to accomplish all control sequences equipment operation including those operations that are provided by the HVAC Equipment Unit manufacturers (UM) & those as part of the Automatic Temperature Controls system (ATC).

C. Responsibilities
   1. Automatic Temperature Control (ATC) Contractor's Responsibilities:
      a. The ATC contractor (ATC) shall provide, field install & wire all necessary software & hardware, wiring, & computing equipment in compliance with this specification. The ATC contractor shall also provide programming, software, color graphics for each system and equipment, interface design, startup services by competent technicians that regularly employed by the ATC contractor with full responsibility for proper operation of the control system including debugging & proper calibration of each component in the entire system
      b. The ATC contractor (ATC) shall provide power supply wiring to all external control panels, actuators (valves, dampers, etc.), including low voltage transformers, including the power for devices required for operation of BACnet communication as provided, as part of complete HVAC Equipment Unit Manufacturer provided BACnet package. Provide and extend wiring, power from panels, disconnect, breakers to all devices.
      c. Provide relays, transformers, switches, interlocks, wiring conduits, supports, terminations. Coordinate all requirements with third party supplied equipment and controls, communications requirements and provide all work.
      d. Provide commissioning of control systems and participate in commissioning of mechanical systems.
   2. Mechanical Contractors (MC) Responsibilities: The Mechanical contractor (MC) shall provide coordination between the HVAC Equipment Unit Manufacturers (UM) & the ATC contractor (ATC) to provide a fully coordinated & operational Automatic Temperature Controls system. Refer to this & the specific equipment specifications & schedules for devices provided, installed & wired by the HVAC equipment Unit manufacturers (UM) & those by the ATC contactor (ATC).
   3. Equipment Unit Manufacturer (UM) Responsibilities: The Equipment Unit Manufacturer (UM) shall provide the equipment and field labor to meet the sequence requirements of this specification & schedules sections. The Equipment Unit Manufacturer (UM) shall provide factory installation & wiring of the ATC provided controls, when specified to be

factory installed.

D. Hot Water System.
   1. System Enable: The Hot Water Heating system shall be “Enabled” when the Outside Air Temperature (OAT) is < the Hot Water System Enable setpoint (HWENAB) of 65 °F or manually via a software selection from the workstation or locally via the onboard monitored H-O-A switch. The system consists of two Hot Water Boilers and hot water circulating pumps. The System shall be “Enabled” for a minimum of 30 minutes.
   2. Hot Water Boilers:
      a. Hot Water Setpoint Reset: The Hot Water Boilers shall be controlled to maintain a Hot Water Setpoint as Reset off of Outside Air between 120°F and 180°F when the outside air temperature is between 60°F and 20°F.
      b. “Lead / Lag” Control: If the selected “Lead” Hot Water Boiler fails to operate after a delay of 60 seconds; The selected “Lag” Hot Water Boiler shall be commanded to “Run”. The selected “Lead” Hot Water Boiler shall be commanded to “Stop”. An alarm shall be generated.
      c. “Rotation” Control: The “Lead” and “Lag” Hot Water Boiler selection shall be rotated every 168 hours of accumulated “Run” time or from a manual selection switch on the GUI.
   3. Hot Water Pump Control (HWP-1, 2):
      a. “Lead / Lag” Control: If the selected “Lead” Hot Water Pump fails to operate after a delay of 30 seconds; The selected “Lag” Hot Water Pump shall be commanded to “Run”. The selected “Lead” Hot Water Pump shall be commanded to “Stop”. An alarm shall be generated.
      b. “Rotation” Control: The “Lead” and “Lag” Hot Water Pump selection shall be rotated every 168 hours of accumulated “Run” time or from a manual selection switch on the GUI.
      c. Pump Start, Stop and Status: Each Hot Water Pump shall be controlled by a Control Relay (R) and monitored by a Current Switch (CS). The “Lead” Hot Water Pump (PL#SS) shall start when the Hot Water System is enabled. The “Lead” Hot Water Pump (PL#SS) shall “Stop if after 30 minutes from the Hot Water System is commanded “Off”.
      d. Pump VFD Fault monitoring: The Pump’s VFD Fault status shall be monitored by the BMS. When the VFD is in a Fault condition an alarm shall be generated.
      e. Hot Water Pump Variable Frequency Drive BACnet Communications Interface: The VFD Manufacturer (UM) shall provide a BACnet MS/TP communications card; all time to coordinate the integration to the ATC & VFDs. The ATC contractor (ATC) shall provide the BACnet MS/TP communications wiring to the VFD BACnet MS/TP communications board; provide all time to integrate the VFD BACnet points
   4. Hot Water System Differential Pressure Control: A Hot Water Differential Pressure sensor (HWDP) shall be located at the end of the Hot Water System mains. The Hot Water Differential Pressure sensors (HWDP) shall be monitored by the BMS DDC controller. The Standby Hot Water Pumps shall be staged “on” when the Hot Water System pressure is unable to be maintained by a single Hot Water Pump. A maximum of two (2) Hot Water pumps shall be in operation. The BMS DDC controller shall modulate the active Hot Water Pump’s VFD speed to maintain the Hot Water System Differential Pressure (HWDPSP) setpoint. If the Hot Water Pump’s VFD speed has reached the minimum setting as dictated by the VFD manufacturer, and a further decrease in the Hot Water Differential Pressure is required, the Hot Water Minimum Bypass Valve (HWBYP) shall be modulated to provide Hot Water Differential Pressure control.
   5. Operator and Graphical User Interface requirements: The Building Management System Control Diagrams and the tables below shall provide for an accurate depiction of the devices, the I/O points, parameters, and alarms shall be displayed on a customized 3-

dimensional web-based graphic.

a. Input/Output Points:

Hot Water System Control	I/O Points						
Point Name/Description/Legend X = DDC I/O L = Local Control A = Adjustable O = Override	AI	AO	BI	BO	Trend	GUI	Device
Hot Water Boiler Integration Points	X	X	X	X	X	X	FL
Hot Water Pump VFD Integration Points	X	X	X	X	X	X	FL
Hot Water Pump Start/Stop (PL#SS)				O	X	X	R
Hot Water Pump Status (PL#CS)			X		X	X	CS
Hot Water Pump Speed Control (PL#AO)		O			X	X	
Hot Water Pump VFD Fault (PL#FLT)			X		X	X	
Hot Water Supply Temperature (HEL#S)	X				X	X	TS-I
Hot Water Return Temperature (HEL#R)	X				X	X	TS-I
Hot Water System Bypass Valve (HWBYP)		O			X	X	CV
Hot Water System Diff. Pressure (HWDP)	A				X	X	DPT
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)							

b. Control Parameters and Settings

Hot Water System Control	Parameters and Settings			
Parameter Name/Description X = Display on GUI C = Concealed A = Adjustable	AV	Trend	GUI	Initial-Setting
Hot Water System Enable Override “On”	X	X	X	
Hot Water System Enable (HWENAB)	A	X	X	55 °F

Hot Water Setpoint (HWSP)	A	X	X	45 °F
HW Pump Lead Runtime until C/O	A	X	C	(Seq.)
HW Pump Lead Selection	A	X	C	P-L-1
HW Pump Lead Runtime C/O Setting	A	X	C	168 hours
HW System Differential Pressure Setpoint	A	X	X	Set by Balancer
All Alarm Setpoint and/or Parameters	A	X	C	Alarm settings
Alarm Reset	A	X	X	
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)				

c. Alarms

HW System Control	Alarms and Conditions		
Alarm Name	Point	Normal	Alarm
# Pump Failure	PL#SS PL#CS	PL#SS = ON PL#CS = ON	#PSS = ON #PCS = OFF
# Pump in Hand	PL#SS PL#CS	PL#SS = OFF PL#CS = OFF	#PSS = OFF #PCS = ON
High/Low Water Temp	HWS		HWS more than HWSP +/- 10°F
VFD Fault	PL#FLT	OFF	ON

E. ROOF TOP Unit – (RTU-1, 2, 3, 4, 5, 6, 7)
   1. Reference the project plans for unit configuration, device locations
   2. Coordination: The Unit Manufacturer (UM) shall provide the Units as outlined under the equipment specifications & schedules. The Mechanical contractor (MC) shall provide coordination between the Unit Manufacturer (UM) & the ATC contractor (ATC) for a complete integrated system. The ATC contractor (ATC) shall field install & wire the unit manufacturers field devices, as required. Additionally, the ATC Contractor shall provide and install a communications integration network from the units to the Building Management System.
   3. Scheduling: The schedule shall be communicated to the Unit's BACnet MS/TP DDC controller as established in the GUI.
   4. Duct Smoke Detection: The Division 26 Electrical Contractor (EC) shall provide the interlock wiring for the Unit shut down; provide the smoke detectors with a spare contact for use by the ATC system; provide, field install & wire the Fire Alarm System (FAS) controls from the FACP panel. The Division 23 Mechanical Contractor (MC) shall be install the smoke detectors.
   5. Operator and Graphical User Interface requirements: The Building Management System Control Diagrams and the tables below shall provide for Operator Control of the HVAC equipment through an accurate depiction of the devices within the unit, along with the I/O points, parameters and alarms shall be displayed on a customized 3-dimensional web-based graphic.

a. Input/Output Points:

RTU – UNIT MANUFACTURER	I/O Points						
Point Name/Description/Legend X = DDC I/O L = Local Control A = Adjustable O = Override	AI	AO	BI	BO	Trend	GUI	Device
Reference Manufacturer BACnet Integration point for a complete list. Following is a general list of control points, AS APPLICABLE)	X	X	X	X	X	X	
Supply Fan Start/Stop (SFSS)				O	X	X	R
Supply Fan Status (SFCS)			X		X	X	CS
Supply Fan ECM Fault (SFFLT)			X		X	X	
Supply Fan ECM Speed (SFAO)		X			X	X	
Return Fan Start/Stop (RFSS)				O	X	X	R
Return Fan Status (RFCS)			X		X	X	CS
Return Fan ECM Fault (RFFLT)			X		X	X	
Return Fan ECM Speed (RFAO)		X			X	X	
Supply Air Temperature (SAT)	X				X	X	TS-D
Cooling Coil Discharge Air Temperature (CCTS)	X				X	X	TS-A
Heating Coil Discharge Air Temperature (HCTS)	X				X	X	TS-A
Mixed Air Temperature (MAT)	X				X	X	TS-A
Return Air Temperature Setpoint (RAT)	X				X	X	TS-D
Return Air Humidity (RAH)	X				X	X	RH-D
Return Air CO2 (RACO2)	X				X	X	CO2-D
Outside Air Flow	X				X	X	AFS

(OACFM)							
Exhaust Air Flow (EACFM)	X				X	X	AFS
Low Temperature Limit Switch (LLS)			X		X	X	LLS
Cooling Stages (CLG)	X	O			X	X	CV
Heating Stages (HTG)	X	O			X	X	CV
Supply Duct Static Pressure (DSP)	X				X	X	DPT
Exhaust Duct Static Pressure (DSP)	X				X		
Outside Air Damper (OAD)	X		X	X	X	X	M
Exhaust Air Damper (EAD)	X		X	X	X	X	M
Liquid Detection Sensor (LDS)			X		X	X	LDS
Filter (FLTR)			X		X	X	DPS
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)							

b. Control Parameters and Settings

RTU – UNIT MANUFACTURER	Parameters and Settings			
Parameter Name/Description X = Display on GUI C = Concealed A = Adjustable	AV	Trend	GUI	Initial-Setting
Reference Manufacturer BACnet Integration point for a complete list. Following is a general list of control points, AS APPLICABLE)	A	X	X	
Discharge Air Setpoint (DASP)	A	X	X	55°F
Discharge Air Temp. Low Limit (DALL)	A	X	C	55°F
Space Temp “Warm-up” Setpoint (WUSP)	A	X	C	2 °F (WUSP – RMT)
OA Intake	A	X	X	Set by Balancer

(OACFMSP)				
Exhaust Air CFM Offset	X		X	Set by Balancer
All Alarm Setpoint and/or Parameters	A	X	C	Alarm settings
Alarm Reset	A	X	X	
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)				

c. Alarms

RTU – UNIT MANUFACTURER	Alarms and Conditions		
Alarm Name	Point	Normal	Alarm
# Fan Failure	#FSS #FCS	#FSS = ON #FCS = ON	#FSS = ON #FCS = OFF
# Fan in Hand	#FSS #FCS	#FSS = OFF #FCS = OFF	#FSS = OFF #FCS = ON
High Air Temperature	#AT		#AT > #ASP+5 °F
Low Air Temperature	#AT		#AT -5 °F < #ASP
Air Flow High/Low	#ACFM		+/- 5% as Set by TAB
Smoke Detector			
Dirty Filter	FLTR	OFF	ON
Liquid Detected	LDS	OFF	ON
High CO2 (HCO2)			> 1100 ppm

F. ENERGY RECOVERY VENTILATOR UNIT – (ERV-1, 2, 3, 4, 5)
1. Reference the project plans for unit configuration, device locations
2. Coordination: The Unit Manufacturer (UM) shall provide the Units as outlined under the equipment specifications & schedules. The Mechanical contractor (MC) shall provide coordination between the Unit Manufacturer (UM) & the ATC contractor (ATC) for a complete integrated system. The ATC contractor (ATC) shall field install & wire the unit manufacturers field devices, as required. Additionally, the ATC Contractor shall provide and install a communications integration network from the units to the Building Management System.
3. Scheduling: The schedule shall be communicated to the Unit's BACnet MS/TP DDC controller as established in the GUI.
4. Duct Smoke Detection: The Division 26 Electrical Contractor (EC) shall provide the interlock wiring for the Unit shut down; provide the smoke detectors with a spare contact for use by the ATC system; provide, field install & wire the Fire Alarm System (FAS) controls from the FACP panel. The Division 23 Mechanical Contractor (MC) shall install the smoke detectors.
5. Operator and Graphical User Interface requirements: The Building Management System Control Diagrams and the tables below shall provide for Operator Control of the HVAC equipment through an accurate depiction of the devices within the unit, along with the I/O points, parameters and alarms shall be displayed on a customized 3-dimensional web-based graphic.
   a. Input/Output Points:

ERV – UNIT MANUFACTURER	I/O Points						
Point Name/Description/Legend	AI	AO	BI	BO	Trend	GUI	Device

X = DDC I/O L = Local Control A = Adjustable O = Override							
Reference Manufacturer BACnet Integration point for a complete list. Following is a general list of control points typical)	X	X	X	X	X	X	
Supply Fan Start/Stop (SFSS)				O	X	X	R
Supply Fan Status (SFCS)			X		X	X	CS
Supply Fan ECM Fault (SFFLT)			X		X	X	
Supply Fan ECM Speed (SFAO)		X			X	X	
Exhaust Fan Start/Stop (EFSS)				O	X	X	R
Exhaust Fan Status (EFCS)			X		X	X	CS
Exhaust Fan ECM Fault (EFFLT)			X		X	X	
Exhaust Fan ECM Speed (EFAO)		X			X	X	
Supply Air Temperature (SAT)	X				X	X	TS-D
Mixed Air Temperature (MAT)	X				X	X	TS-A
Return Air Temperature Setpoint (RAT)	X				X	X	TS-D
Supply Air Humidity (SAH)	X				X	X	RH-D
Return Air Humidity (RAH)	X				X	X	RH-D
Outside Air Damper (OAD)	X		X	X	X	X	M
Exhaust Air Damper (EAD)	X		X	X	X	X	M
Filter (FLTR)			X		X	X	DPS
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)							

b. Control Parameters and Settings

ERV – UNIT MANUFACTURER	Parameters and Settings			
Parameter Name/Description X = Display on GUI C = Concealed A = Adjustable	AV	Trend	GUI	Initial-Setting
Reference Manufacturer BACnet Integration point for a complete list. Following is a general list of control points typical)	A	X	X	
Discharge Air Setpoint (DASP)	A	X	X	55°F
Discharge Air Temp. Low Limit	A	X	C	55°F

(DALL)				
All Alarm Setpoint and/or Parameters	A	X	C	Alarm settings
Alarm Reset	A	X	X	
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)				

c. Alarms

ERV – UNIT MANUFACTURER	Alarms and Conditions		
Alarm Name	Point	Normal	Alarm
# Fan Failure	#FSS #FCS	#FSS = ON #FCS = ON	#FSS = ON #FCS = OFF
# Fan in Hand	#FSS #FCS	#FSS = OFF #FCS = OFF	#FSS = OFF #FCS = ON
High Air Temperature	#AT		#AT > #ASP+5 °F
Low Air Temperature	#AT		#AT -5 °F < #ASP
Dirty Filter	FLTR	OFF	ON
Liquid Detected	LDS	OFF	ON
High CO2 (HCO2)			> 1100 ppm

G. MAKEUP AIR Unit – (MAU-1, 2)
1. Reference the project plans for unit configuration, device locations
2. Coordination: The Unit Manufacturer (UM) shall provide the Units as outlined under the equipment specifications & schedules. The Mechanical contractor (MC) shall provide coordination between the Unit Manufacturer (UM) & the ATC contractor (ATC) for a complete integrated system. The ATC contractor (ATC) shall field install & wire the unit manufacturers field devices, as required. Additionally the ATC Contractor shall provide and install a communications integration network from the units to the Building Management System.
3. Scheduling: The schedule shall be communicated to the Unit's BACnet MS/TP DDC controller as established in the GUI.
4. Duct Smoke Detection: The Division 26 Electrical Contractor (EC) shall provide the interlock wiring for the Unit shut down; provide the smoke detectors with a spare contact for use by the ATC system; provide, field install & wire the Fire Alarm System (FAS) controls from the FACP panel. The Division 23 Mechanical Contractor (MC) shall install the smoke detectors.
5. Operator and Graphical User Interface requirements: The Building Management System Control Diagrams and the tables below shall provide for Operator Control of the HVAC equipment through an accurate depiction of the devices within the unit, along with the I/O points, parameters and alarms shall be displayed on a customized 3-dimensional web-based graphic.
   a. Input/Output Points:

MAU – UNIT MANUFACTURER	I/O Points						
Point Name/Description/Legend X = DDC I/O L = Local Control	AI	AO	BI	BO	Trend	GUI	Device

A = Adjustable O = Override							
Reference Manufacturer BACnet Integration point for a complete list. Following is a general list of control points, AS APPLICABLE)	X	X	X	X	X	X	
Supply Fan Start/Stop (SFSS)				O	X	X	R
Supply Fan Status (SFCS)			X		X	X	CS
Supply Fan ECM Fault (SFFLT)			X		X	X	
Supply Fan ECM Speed (SFAO)		X			X	X	
Return Fan ECM Speed (RFAO)		X			X	X	
Supply Air Temperature (SAT)	X				X	X	TS-D
Heating Coil Discharge Air Temperature (HCTS)	X				X	X	TS-A
Outside Air Flow (OACFM)	X				X	X	AFS
Heating Stages (HTG)	X	O			X	X	CV
Outside Air Damper (OAD)	X		X	X	X	X	M
Filter (FLTR)			X		X	X	DPS
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)							

b. Control Parameters and Settings

RTU – UNIT MANUFACTURER	Parameters and Settings			
Parameter Name/Description X = Display on GUI C = Concealed A = Adjustable	AV	Trend	GUI	Initial-Setting
Reference Manufacturer BACnet Integration point for a complete list. Following is a general list of control points, AS APPLICABLE)	A	X	X	
Discharge Air Setpoint (DASP)	A	X	X	55°F
Discharge Air Temp. Low Limit (DALL)	A	X	C	55°F
All Alarm Setpoint and/or Parameters	A	X	C	Alarm settings
Alarm Reset	A	X	X	
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)				

c. Alarms

RTU – UNIT MANUFACTURER	Alarms and Conditions		
Alarm Name	Point	Normal	Alarm
# Fan Failure	#FSS #FCS	#FSS = ON #FCS = ON	#FSS = ON #FCS = OFF
# Fan in Hand	#FSS #FCS	#FSS = OFF #FCS = OFF	#FSS = OFF #FCS = ON
High Air Temperature	#AT		#AT > #ASP+5 °F
Low Air Temperature	#AT		#AT -5 °F < #ASP
Smoke Detector			
Dirty Filter	FLTR	OFF	ON

H. Variable Air Volume Box – with Hot Water Coil:
   1. Coordination: The BMS contractor shall provide a BACnet DDC controller, with integral actuator to the VAV Factory in a timely manner for installation by VAV manufacturer, if the VAV controller and actuator are not installed at VAV manufacturers facility, the devices shall be field installed by the ATC contractor; provide, field install & wire a Space Temperature Sensor (RMT) or Return Air Temperature Sensor (See project plans for locations).. The Variable Air Box Unit Manufacturer (UM) shall provide the Variable Air Volume Box complete with a cross flow sensor; a Control power Transformer & Enclosure; and factory installation of the BMS Contractor provided DDC controller. The Testing & Balancing contractor (TAB) shall measure the Variable Air Volume box air flow, set the air flow setpoints, adjust & calibrate the VAV cross flow sensors.
   2. Scheduling: The schedule shall be communicated to the Unit's BACnet MS/TP DDC controller as established in the GUI.
   3. Space Temperature Sensor or Return Air (RMT or RAT, See project Drawings for location): The Space Temperature Sensor (RMT) shall have a g Blank plate with setpoint adjustment and override push-button. The setpoints shall be initially set at 72 °F (adj.) for heating (HSP) & 74 °F (adj.) for cooling (CSP).
   4. "Unoccupied": The Source HVAC Equipment Supply Fan (SFSS) shall run continuously. The Variable Air Volume will control the space to the Unoccupied setpoints.
   5. "Unoccupied Cooling" mode: The Variable Air Volume Box dampers shall modulate to maintain the "Unoccupied" Cooling Setpoint (UCSP).
   6. "Unoccupied Heating" mode: The Variable Air Volume Box damper and reheat control valve shall modulate to maintain the "Unoccupied" Heating Setpoint (UHSP)
   7. "Occupied" mode: The Source HVAC Equipment Supply Fan (SFSS) shall run continuously. The Variable Air Volume Box damper shall modulate to maintain the airflow (CFM) at the Calculated Air Flow Setpoint (CFMSP). The Calculated Air Flow Setpoint (CFMSP) is derived from the Temperature differential between the Space Temperature (RMT) & the Heating & Cooling Setpoints (HSP/CSP) and shall be varied between the Maximum Air Flow Setting (CFMMAX) & Minimum Air Flow Setting (CFMMIN).
   8. Heating mode: If the Control Temperature (RMT or RAT) is < the Space Heating Setpoint (HSP), the Variable Air Volume Box BACnet DDC controller shall modulate the VAV box damper to maintain the minimum airflow (CFMMIN) or the minimum heating airflow (CFMHTG), the Fintube Radiation Hot Water Valve (FTR) and the Hot Water Valve (HWV) shall then modulate "open" in sequence to maintain the space heating Setpoint (HSP). If the Control Temperature (RMT or RAT) is > the Space Heating Setpoint (HSP) hysteresis, the Variable Air Volume Box BACnet DDC controller shall modulate "closed" the Fintube Radiation Hot Water Valve (FTR) and the Hot Water Valve (HWV) in sequence, and then modulate "open" the Variable Air Volume Box dampers between the greater of the minimum airflow (CFMMIN) & the maximum airflow (CFMMAX)

9. Cooling mode: If the Control Temperature (RMT or RAT) is > the Space Cooling Setpoint (CSP), the Variable Air Volume Box BACnet DDC controller shall modulate the Variable Air Volume Box damper between the minimum airflow (CFMMIN) & the maximum airflow (CFMMAX). If the Control Temperature (RMT or RAT) is < the Space Cooling Setpoint (CSP) hysteresis, the Variable Air Volume Box BACnet DDC controller shall modulate the Variable Air Volume Box damper between the maximum airflow (CFMMAX) & the minimum airflow (CFMMIN)
10. Operator and Graphical User Interface requirements: The Building Management System Control Diagrams and the tables below shall provide for Operator Control of the HVAC equipment through an accurate depiction of the devices within the unit, along with the I/O points, parameters and alarms shall be displayed on a customized 3-dimensional web-based graphic.
    a. Input/Output Points:

VAV Box – w/Heating	I/O Points						
Point Name/Description/Legend X = DDC I/O L = Local Control A = Adjustable O = Override	AI	AO	BI	BO	Trend	GUI	Device
VAV Supply Air Temperature (SAT)	X				X	X	TS-D
Space or Return Air Temperature (RMT or RAT)	X				X	X	TS-W/D
Box Air Velocity and Static Pressure (DSP)	X				X	X	DPT
Fintube Radiation Hot Water Valve (FTR)		X			X	X	
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)							

    b. Control Parameters and Settings

VAV Box – w/Heating	Parameters and Settings			
Parameter Name/Description X = Display on GUI C = Concealed A = Adjustable	AV	Trend	GUI	Initial-Setting
VAV Occupancy (OCC)	A	X	X	
VAV Damper position (DAMPER)	A	X	X	
VAV Air Flow (CFM)	A	X	X	Set by Balancer
“Occupied” Heating Setpoint (HSP)	A	X	A	70 °F
“Occupied” Cooling Setpoint (CSP)	A	X	A	74 °F
“Unoccupied” Heating Setpoint (UHSP)	A	X	A	64 °F
“Unoccupied” Cooling Setpoint (UCSP)	A	X	A	78 °F
CFM Minimum Setting (CFMMIN)	A	X	X	Set by Balancer
CFM Maximum Setting (CFMMAX)	A	X	X	Set by

				Balancer
CFM Heating Setting (CFMHTG)	A	X	X	Set by Balancer
CFM Setpoint (CFMSP)	A	X	X	Calculated
Alarm Reset (RESET)	A	X	A	
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)				

c. Alarms

VAV Box – w/Heating	Alarms and Conditions		
Alarm Name	Point	Normal	Alarm
High Space Temperature	RMT		RMT more than 78 °F
Low Space Temperature	RMT		RMT less than 60 °F
High Supply Air Temperature	SAT		SAT more than 140 °F
Low Supply Air Temperature	SAT		SAT less than 45 °F
Air Flow	CFM	CFMSP	CFM > 10% from CFMSP

I. Constant & Variable Air Box Balancing

1. Coordination: The Testing and Air Balancer contractor (TAB) shall utilize their own laptop computer for use of the System VAV Balancing Software. The Testing and Air Balancer contractor (TAB) shall provide the initial air balancing & setting of the design minimum & maximum air flow for each box. The ATC Contractor (ATC) shall provide the required software programs to the Testing and Balancing contractor (TAB) for balancing the VAV boxes, shall coordinate and participate throughout in calibration, adjustment testing and balancing of systems with the Testing and Balancing contractor (TAB).

J. Fintube, Radiators and Convectors

1. Scheduling and control: As identical to the associated BACnet DDC controller's schedule and Space Temperature sensor (RMT), and Heating setpoint.
2. "Unoccupied": The Heating Control valve (FTR) shall be commanded "closed". "Unoccupied Heating": When the Space Temperature (RMT) < the "Unoccupied Heating" Setpoint (UHSP) the Heating Control valve (FTR) shall be commanded "open". When the Space Temperature (RMT) > the "Unoccupied Heating" Setpoint (UHSP) hysteresis, the Heating Control valve (FTR) shall be commanded "closed".
3. "Occupied": When the Space Temperature (RMT) < the "Occupied Heating" Setpoint (HSP) the Heating Control valve (FTR) shall be commanded "open". When the Space Temperature (RMT) > the "Occupied Heating" Setpoint (HSP) hysteresis, the Heating Control valve (FTR) shall be commanded "closed". The Fintube and heating valve shall be sequenced in coordination with the VAV Box damper and reheat valve.
4. Operator and Graphical User Interface requirements: The Building Management System Control Diagrams and the tables below shall provide for Operator Control of the HVAC equipment through an accurate depiction of the devices within the unit, along with the I/O points, parameters and alarms shall be displayed on a customized 3-dimensional web-based graphic.
   a. Input/Output Points:

Fintube Radiators and Convectors	I/O Points						
Point Name/Description/Legend X = DDC I/O L = Local Control A = Adjustable O = Override	AI	AO	BI	BO	Trend	GUI	Device
Space Temperature (RMT)	X				X	X	TS-W
Heating Control valve (FTR)				X	X	X	CV

Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)

b. Control Parameters and Settings

Fintube Radiators and Convectors	Parameters and Settings			
Parameter Name/Description X = Display on GUI C = Concealed A = Adjustable	AV	Trend	GUI	Initial-Setting
“Unoccupied” Space Heating Setpoint (UHSP)	X		X	60 °F
“Occupied” Space Heating Setpoint (HSP)	X		X	70 °F
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)				

c. Alarms

Fintube Radiators and Convectors	Alarms and Conditions		
Alarm Name	Point	Normal	Alarm
High Air Temperature	RMT		#AT > #HSP+5 °F
Low Air Temperature	RMT		#AT -5 °F < #HSP

K. Cabinet/Unit Heater – (GUH-1, 2)

1. Control: The Building Management System contractor (BMSC) shall provide, install, and wire an electric Thermostat (TC) with local setpoint (adj.). The Space Heating Setpoint (LHSP) is initially set at 70°F (adj.). When the temperature is less than the Thermostat (TC) Heating Setpoint (LHSP), the Unit’s fan shall start, and the Natural Gas heat shall stage to maintain the space temperature When the space temperature is more than the Thermostat (TC) Heating Setpoint (LHSP) hysteresis, the Natural Gas heat shall be cycled “off” and . the Cabinet/Unit heater’s Fan shall stop.

L. Outside Air Temperature, Humidity and CO2 Monitoring

1. The Building Management System contractor (BMSC) shall provide, install, and wire an Outside Air temperature, Carbon-Dioxide and humidity sensors with a weather/sunshields enclosure on a northern exposure of the building.
2. Operator and Graphical User Interface requirements: The Building Management System Control Diagrams and the tables below shall provide for Operator Control of the HVAC equipment through an accurate depiction of the devices within the unit, along with the I/O points, parameters and alarms shall be displayed on a customized 3-dimensional web-based graphic.
   a. Input/Output Points:

Global OAT, OARH OACO2	I/O Points						
Point Name/Description/Legend X = DDC I/O L = Local Control A = Adjustable O = Override	AI	AO	BI	BO	Trend	GUI	Device
Outside Air Temperature (OAT)	X				X	X	TS-O

Outside Air Humidity (OAH)	X				X	X	RH-O
Outside Air Humidity (OACO2)	X				X	X	CO2-O
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)							

b. Control Parameters and Settings

Global OAT, OARH OACO2	Parameters and Settings			
Parameter Name/Description X = Display on GUI C = Concealed A = Adjustable	AV	Trend	GUI	Initial-Setting
All Alarm Setpoint and/or Parameters	A	X	C	Alarm settings
Highest Values (Past24 hours)	X	X	X	
Lowest Values (Past 24 Hours)	X	X	X	
Calculated ° Days (Monthly)	X	X	X	
Calculated Enthalpy (btu/lbs.)	X	X	X	
Alarm Reset	A	X	X	
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)				

c. Alarms

Global OAT, OARH OACO2	Alarms and Conditions		
Alarm Name	Point	Normal	Alarm
Sensor Failure	OA#		Invalid

M. General Exhaust Fans (EF-1, 2, 3, 4)

1. Scheduling: The schedule shall be identical to the associated HVAC unit in the “Occupied”.
2. Operator and Graphical User Interface requirements: The Building Management System Control Diagrams and the tables below shall provide for Operator Control of the HVAC equipment through an accurate depiction of the devices within the unit, along with the I/O points, parameters and alarms shall be displayed on a customized 3-dimensional web-based graphic.
   a. Input/Output Points:

General Exhaust Fan	I/O Points						
Point Name/Description/Legend X = DDC I/O L = Local Control A = Adjustable O = Override	AI	AO	BI	BO	Trend	GUI	Device
Exhaust Fan Start/Stop (EFSS)				O	X	X	R
Exhaust Fan Status (EFCS)			X		X	X	CS
Exhaust Air damper (EAD)			L			X	M
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)							

   b. Control Parameters and Settings

General and Toiler Exhaust Fan	Parameters and Settings

Parameter Name/Description X = Display on GUI C = Concealed A = Adjustable	AV	Trend	GUI	Initial-Setting
All Alarm Setpoint and/or Parameters	A	X	C	Alarm settings
Alarm Reset	A	X	X	
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)				

c. Alarms

General and Toiler Exhaust Fan	Alarms and Conditions		
Alarm Name	Point	Normal	Alarm
# Fan Failure	#FSS #FCS	#FSS = ON #FCS = ON	#FSS = ON #FCS = OFF
# Fan in Hand	#FSS #FCS	#FSS = OFF #FCS = OFF	#FSS = OFF #FCS = ON

N. Fire Alarm Control Panel (FACP) Interface:

1. The Fire Alarm Control Panel (FACP) shall signal the Building Management System that the FACP is in the alarm.
2. The FACP system shall shut down the unit directly. When the FACP system signals an Emergency Shutdown condition, all of the DDC controlled equipment shall be is commanded “off”, including the hydronic and air ventilation equipment via the BMS communications bus.
3. This is a secondary shutdown signal to shut-down of the BMS equipment and is to prevent erroneous alarms being generated during a FACP shutdown and is not considered a life safety function.
4. Operator and Graphical User Interface requirements: The Building Management System Control Diagrams and the tables below shall provide for Operator Control of the HVAC equipment through an accurate depiction of the devices within the unit, along with the I/O points, parameters and alarms shall be displayed on a customized 3-dimensional web-based graphic.

a. Input/Output Points:

FACP Panel	I/O Points						
Point Name/Description/Legend X = DDC I/O L = Local Control A = Adjustable O = Override	AI	AO	BI	BO	Trend	GUI	Device
FACP Emergency Status (FACP)			X		X	X	CS
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)							

b. Alarms

FACP Panel	Alarms and Conditions		
Alarm Name	Point	Normal	Alarm
FACP Panel	FACP	FACP = ON	FACP = OFF

O. SMOKE EXHAUST FANS, Smoke DAMPERS (SM), & Fire/Smoke Damper Control (F/SD)
   1. Coordination:
      a. The Division 26 Electrical contractor (EC) shall provide interlock & power wiring of the Smoke (S), & Fire/Smoke dampers (F/SD) between the FACP, including any local test station, indication panel, and the safety shutdown circuit.
      b. The Division 26 Electrical Contractor (EC) shall provide the power wiring; fire alarm system control wiring & test station wiring to the Smoke & Fire/Smoke dampers.
      c. The Division 26 Electrical Contractor (EC) shall coordinate with the ATC contractor (ATC) for the FACP override of the unit dampers.
      d. The Division 26 Electrical Contractor shall wire the unit to start directly through the Fire Alarm System (FAS).
      e. The Division 23 Mechanical contractor (MC) shall provide & install the Fire/Smoke dampers with actuators. The Fire/Smoke damper actuators shall have a spare status contact for use by the BMS system.
      f. The Division 23 ATC contractor (ATC) shall coordinate with the Division 26 Electrical Contractor (EC) to control the Fire/Smoke (F/SD) dampers in accordance with the Sequence of Operations. The Division 23 ATC Contractor (ATC) shall also provide and install any required low voltage control wiring between the BMS BACnet DDC controller & the Fire/Smoke (F/SD) dampers.
      g. The Division 23 ATC contractor (ATC) shall wire the first Return and Supply Duct Fire/Smoke spare status contacts to the local BMS BACnet DDC controller.
      h. A secondary signal from the Fire Alarm System shall be wired to send a signal to the ATC BACnet DDC controllers.
   2. Operation:
      a. Upon startup, the BMS shall indicate to the Fire Alarm System (FAS) the request to open the unit's respective Fire/Smoke dampers. Once the Fire Alarm System (FAS) indicates that the equipment's F/SD damper are open via a hard-wired connection to the first Supply and Return Fire/Smoke damper end switch has proven the dampers Open, the unit shall start.
      b. Upon a smoke condition, as sensed by the unit's respective smoke detector, the Fire Alarm System (FAS) shall disable the unit & the Fire/Smoke dampers shall close.
      c. The Fire Alarm System (FAS) shall notify the BMS through a set of contacts of this condition.
   3. Operator and Graphical User Interface requirements
      a. The Building Management System Control Diagrams and the tables below shall provide for Operator Control of the HVAC equipment through an accurate depiction of the devices within the unit, along with the I/O points, parameters and alarms shall be displayed on a customized 3-dimensional web-based graphic.
      b. Input/Output Points:

BMS-FAS Interface	I/O Points						
Point Name/Description/Legend X = DDC I/O L = Local Control A = Adjustable O = Override	AI	AO	BI	BO	Trend	GUI	Device
BMS Unit Command to				X	X	X	

Start – to FAS							
FAS to BMS Unit Enabled			X				
Supply Air F/SD End Switch “Open”			X				
Return Air F/SD End Switch “Open”			X				
Analog Trends shall record data samples every 5 minutes, unless noted otherwise. Binary Trends shall record data samples every Change of Value (COV)							

c. Control Parameters and Settings
   1) None

d. Alarms

BMS-FAS Interface	Alarms and Conditions		
Alarm Name	Point	Normal	Alarm
FAS in Alarm	FAS	ON	OFF

P. Duct Smoke Detection
   1. Coordination:
      a. The Division 26 Electrical Contractor (EC) shall provide the smoke detectors and the wiring for the Fire Alarm System (FAS) including any shutdown, purge sequences from the FACP panel.
      b. The Division 23 Mechanical contractor shall install the smoke duct detector, with a spare contact for use by the BMS, as needed.
      c. The ATC contractor (ATC) shall wire the smoke detector spare contact to the local BACnet DDC controller to disable control loops during a smoke condition.

Q. Variable Frequency Drives (VFD)
   1. VFD’s shall have four district modes of operation:
      a. OFF – VFD and motor are off.
      b. HAND – VFD output is manually controlled via speed selector input on drive.
      c. AUTO – VFD output is controlled by BAS.
   2. VFD’s shall have full communication capabilities with the BAS. Provide all interfaces, gateways, etc. as required for communications between the VFD’s and BAS.

R. Graphical User Interface (GUI)
   1. Graphical User Interface – Workstation (GUI): The ATC contractor (ATC) shall provide a TCP/IP connected Workstation with the ability to read, adjust & override the various parameters for system control; provide each of the DDC controlled equipment with graphics with a minimum of the complete I/O point listing, their associated setpoints & any other variable for the adjustment & operation of the system.
   2. Graphical User Interface - Liquid Crystal Display (LCD): The ATC contractor (ATC) shall provide a Panel Mounted connected Liquid Crystal Display where shown, with the ability to read, adjust & override the various parameters for system control. Provide each of the DDC controlled equipment with graphics with a minimum of the complete I/O point listing, their associated setpoints & any other variable for the adjustment & operation of the system. Demonstrate the operation of the system to the owner prior to acceptance of the system.
   3. Graphical User Interface Demonstration: Demonstrate the Graphics, trending & communications setup to the owner prior to acceptance of the system.
   4. Alarm Notification: The system shall notify the owner of an alarming condition via both Visual Alerts & Audible sounds at the GUI. If connected via a TCP/IP connection, an e-mail shall be sent depending on each individual user configuration. Investigation of the alarming condition shall be provided through a common browser connected to the BMS

through a TCP/IP connection.

S. Commissioning
   1. Startup: The Building Management System shall be set up and checked by factory trained competent technicians skilled in the setting and adjustment of the Building Management System equipment used in this project. The technicians are to be experienced in the type of HVAC systems associated with this project.
   2. Demonstration: At the completion of the commissioning, The Building Management System contractor (BMSC) shall: demonstrate the sequence of operations for each system to the Architect or representative.

T. Owner Training and O&M manual
   1. The Building Management System contractor (BMSC) shall provide 40 hours of training to the Owner's personnel. The Training is to include the operation and maintenance of the control system. Training shall be provided after the system has been commissioned and demonstrated to the Architect or representative.
   2. Provide Operation and Maintenance Manual for Controls System in Hard Cover Binder with Flow Diagrams, List of Equipment, Brochures, Cutsheet of Devices and equipment, setpoints, ranges, alarm points, front end network information, spare parts maintenance requirements, maintenance schedules, resets, overrides, sequence of operations, wiring diagrams, system, architecture, and communications diagrams.

1.02 PART 1 PRODUCTS (NOT APPLICABLE)

1.03 PART 1 EXECUTION (NOT APPLICABLE)

END OF SECTION

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SECTION 23 2113
HYDRONIC PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Hydronic system requirements.

B. Heating water piping, above grade.

C. Equipment drains and overflows.

D. Unions, flanges, mechanical couplings, and dielectric connections.

E. Valves:

F. Flow controls.

1.03 RELATED REQUIREMENTS

A. Section 23 0516 - Expansion Fittings and Loops for HVAC Piping.

B. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

1.04 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

D. ASME B31.9 - Building Services Piping.

E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

F. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

G. ASTM B32 - Standard Specification for Solder Metal.

H. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

I. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).

J. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

K. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

L. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

M. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

N. ASTM D2855 - Standard Practice for the Two-Step (Primer & Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.

O. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

P. AWS D1.1/D1.1M - Structural Welding Code - Steel.

Q. AWWA C606 - Grooved and Shouldered Joints.

R. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.06 SUBMITTALS

A. Product Data:
   1. Include data on pipe materials, pipe fittings, valves, and accessories.
   2. Provide manufacturers catalogue information.
   3. Indicate valve data and ratings.
   4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
   1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
   2. Grooved mechanical joints are not permitted in any location.
      a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
      b. Use rigid joints unless otherwise indicated.
   3. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges or unions to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.

D. Valves: Provide valves where indicated:
   1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.
   2. For throttling, bypass, or manual flow control services, use ball valves.

E. Welding Materials and Procedures: Conform to ASME BPVC-IX.

2.02 HEATING WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
   1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
   2. Threaded Joints: ASME B16.3, malleable iron fittings.
   3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn, using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
      a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
      b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
   2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

2.03 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn; using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

B. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
   1. Fittings: ASTM D2466 or D2467, PVC.
   2. Joints: Solvent welded in accordance with ASTM D2855.

2.04 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.
   3. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.

B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.05 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches and Less:
   1. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe 2 Inches and Greater:

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
   1. Dimensions and Testing: In accordance with AWWA C606.
   2. Mechanical Couplings: Comply with ASTM F1476.
   3. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
   4. When pipe is field grooved, provide coupling manufacturer's grooving tools.

D. Dielectric Connections:
   1. Waterways:
      a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
      b. Dry insulation barrier able to withstand 600 volt breakdown test.

c. Construct of galvanized steel with threaded end connections to match connecting piping.
d. Suitable for the required operating pressures and temperatures.

2.06 FLOW CONTROLS

A. Manufacturers:
1. Griswold Controls
2. ITT Bell & Gossett
3. Taco, Inc
4. Victaulic Company

B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.

C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare piping connections to equipment using jointing system specified.

E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

F. After completion, fill, clean, and treat systems. Refer to Section 23 2500 for additional requirements.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install heating water piping to ASME B31.9 requirements.

C. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

D. Route piping in orderly manner, parallel to building structure, and maintain gradient.

E. Install piping to conserve building space and to avoid interfere with use of space.

F. Group piping whenever practical at common elevations.

G. Sleeve pipe passing through partitions, walls and floors.

H. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.

I. Slope piping and arrange to drain at low points.

J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 0516.
1. Flexible couplings may be used in header piping to accommodate thermal growth, thermal contraction in lieu of expansion loops.

K. Use eccentric reducers to maintain top of pipe level.

L. Install valves with stems upright or horizontal, not inverted.

END OF SECTION

SECTION 23 2114
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 RE4LATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Expansion tanks.

B. Air vents.

C. Air separators.

D. Strainers.

E. Pressure-temperature test plugs.

F. Balancing valves.

G. Flow meters.

H. Relief valves.

1.03 RELATED REQUIREMENTS

A. Section 23 2113 - Hydronic Piping.

1.04 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.06 SUBMITTALS

A. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 EXPANSION TANKS

A. Manufacturers:
   1. Amtrol Inc
   2. ITT Bell & Gossett
   3. Taco, Inc

B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible EPDM diaphragm or bladder sealed into tank, and steel support stand.

C. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psi.

D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.02 AIR VENTS

A. Manufacturers:
   1. Armstrong International, Inc
   2. ITT Bell & Gossett
   3. Taco, Inc

B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

2.03 AIR SEPARATORS

A. Coalescing Air/Dirt Separators:
   1. Manufacturers:
      a. Armstrong International, Inc
      b. ITT Bell & Gossett
      c. Spirotherm, Inc
   2. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1; for 150 psi operating pressure and 270 degrees F maximum operating temperature; subject to the requirements of the application and the manufacturer's standard maximum operating conditions.
   3. Coalescing Medium: Provide stainless steel medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location.
   4. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi, threaded to the top of the separator.
   5. Inlet and Outlet Connections: Threaded for 2 NPS and smaller; Class 150 flanged connections for 2-1/2 NPS and larger.
   6. Blowdown Connection: Threaded.
   7. Size: Match system flow capacity.

2.04 STRAINERS

A. Manufacturers:
   1. Armstrong International, Inc
   2. Flexicraft Industries
   3. Grinnell Products, a Tyco Business
   4. The Metraflex Company

B. Size 2 inch and Under:
   1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

2.05 PRESSURE-TEMPERATURE TEST PLUGS

A. Manufacturers:
   1. Ferguson Enterprises Inc
   2. Peterson Equipment Company Inc
   3. Sisco Manufacturing Company Inc

B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.

C. Application: Use extended length plugs to clear insulated piping.

2.06 BALANCING VALVES

A. Manufacturers:
   1. Armstrong International, Inc
   2. Ferguson Enterprises Inc
   3. Hays Fluid Controls
   4. ITT Bell & Gossett
   5. Taco, Inc

B. Size 2 inch and Smaller:
   1. Provide ball style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
   2. Metal construction materials consist of bronze or brass.
   3. Non-metal construction materials consist of EPDM.

2.07 FLOW METERS

A. Manufacturers:
   1. Dwyer Instruments, Inc
   2. EMCO Flow Systems

2.08 RELIEF VALVES

A. Manufacturers:
   1. Apollo Valves
   2. Armstrong International, Inc
   3. ITT Bell & Gossett
   4. Conbraco Industries

B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.

B. Provide manual air vents at system high points and as indicated.

C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

D. Provide air separator on suction side of system circulation pump and connect to expansion tank.

E. Provide valved drain and hose connection on strainer blow down connection.

F. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.

G. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

H. Pipe relief valve outlet to nearest floor drain.

END OF SECTION

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SECTION 23 2123
HYDRONIC PUMPS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Base-mounted pumps.

1.03 REFERENCE STANDARDS

A. UL 778 - Standard for Motor-Operated Water Pumps.

1.04 SUBMITTALS

A. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Armstrong Fluid Technology, Inc

B. Bell & Gossett, a Xylem Inc. brand

C. Taco.

2.02 HVAC PUMPS - GENERAL

A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to Authority Having Jurisdiction as suitable for the purpose specified and indicated.

2.03 BASE-MOUNTED PUMPS

A. Type: Horizontal shaft, single stage, direct connected, radially or horizontally split casing, for 125 psi maximum working pressure.

B. Casing: Cast iron, or ductile iron with suction and discharge gauge ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.

C. Impeller: Bronze, fully enclosed, keyed to shaft.

D. Bearings: Oil lubricated roller or ball bearings.

E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.

F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.

G. Drive: Flexible coupling with coupling guard.

H. Baseplate: Cast iron or fabricated steel with integral drain rim.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.

C. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.

D. Provide drains for bases and seals, piped to and discharging into floor drains.

E. Check, align, and certify alignment of base-mounted pumps prior to start-up.

F. Lubricate pumps before start-up.

END OF SECTION

SECTION 23 2300
REFRIGERANT PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Piping.

B. Refrigerant.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants.

B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

C. ASME B31.5 - Refrigeration Piping and Heat Transfer Components.

D. ASME B31.9 - Building Services Piping.

E. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

F. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

G. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.04 SYSTEM DESCRIPTION

A. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.

1.05 SUBMITTALS

A. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

2.02 PIPING

A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
   1. Fittings: ASME B16.22 wrought copper.
   2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.

B. Pipe Supports and Anchors:
   1. Provide hangers and supports that comply with MSS SP-58.
      a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
5. Vertical Support: Steel riser clamp.
6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
8. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.03 REFRIGERANT

A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

B. Refrigerant: R-410A as defined in ASHRAE Std 34.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and avoid interference with use of space.

D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

3.03 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ASME B31.5.

B. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.

END OF SECTION

SECTION 23 2500
HVAC WATER TREATMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Materials.
   1. System cleaner.
   2. Closed system treatment (water).

B. By-pass (pot) feeder.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

C. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum five years of documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. AmSolv-Amrep, Inc

B. GE Water & Process Technologies

C. Nalco, an Ecolab Company

2.02 REGULATORY REQUIREMENTS

A. Comply with applicable codes for addition of non-potable chemicals to building mechanical systems and to public sewage systems.

2.03 MATERIALS

A. System Cleaner:
   1. Manufacturers:
      a. AmSolv-Amrep, Inc
      b. GE Water & Process Technologies
      c. Nalco, an Ecolab Company
   2. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite or microbiocides such as quarternary ammonia compounds, tributyltin oxide, methylene bis (thiocyanate).

B. Closed System Treatment (Water):
   1. Manufacturers:
      a. AmSolv-Amrep, Inc.
      b. GE Water & Process Technologies
      c. Nalco, an Ecolab Company
   2. Sequestering agent to reduce deposits and adjust pH; polyphosphate.

3. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
4. Conductivity enhancers; phosphates or phosphonates.

2.04 BY-PASS (POT) FEEDER

A. Manufacturers:
1. Griswold Controls
2. J. L. Wingert Company
3. Neptune, a brand of the Dover Company

B. 6.0 gal quick opening cap for working pressure of 175 psi.

PART 3 EXECUTION

3.01 PREPARATION

A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

B. Place terminal control valves in open position during cleaning.

C. Verify that electric power is available and of the correct characteristics.

3.02 CLEANING SEQUENCE

A. Concentration:
1. As recommended by manufacturer.

B. Hot Water Heating Systems:
1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
3. Circulate for 6 hours at design temperatures, then drain.
4. Refill with clean water and repeat until system cleaner is removed.

C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect.

D. Remove, clean, and replace strainer screens.

E. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.04 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

3.05 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
1. Provide minimum of two hours of instruction for two people.
2. Have operation and maintenance data prepared and available for review during training.

3. Conduct training using actual equipment after treated system has been put into full operation.

END OF SECTION

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SECTION 23 3100
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Metal ductwork.

B. Kitchen hood ductwork.

1.03 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

F. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

G. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

H. UL 2221 - Tests of Fire Resistive Grease Duct Enclosure Assemblies.

1.04 SUBMITTALS

A. Product Data: Provide data for duct materials and duct liner.

1.05 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES

A. Regulatory Requirements: Construct ductwork to NFPA 90A standards.

B. Ducts: Galvanized steel, unless otherwise indicated.

C. Low Pressure Supply (System with Cooling Coils, downstream of air terminal units): 2 inch w.g. pressure class, galvanized steel.

D. Medium and High Pressure Supply (upstream of air terminal units): 4 inch w.g. pressure class, galvanized steel.

E. Return and Relief: 2 inch w.g. pressure class, galvanized steel.

F. General Exhaust: 2 inch w.g. pressure class, galvanized steel.

G. Dishwasher Exhaust: 1 inch w.g. pressure class, stainless steel.
   1. Construct of 18 gage, 0.0500 inch stainless steel using continuous external welded joints in rectangular sections.

H. Grease Exhaust: 1 inch w.g. pressure class, stainless steel.

1. Construct of 18 gage, 0.0500 inch stainless steel.
2. Construction:
    a. Liquid tight with continuous external weld for all seams and joints.
    b. Where ducts are not self draining back to equipment, provide low point drain pocket with copper drain pipe to sanitary sewer.
3. Access Doors:
    a. Provide for duct cleaning inside horizontal duct at drain pockets, every 20 feet and at each change of direction.
    b. Use same material and thickness as duct with gaskets and sealants rated 1500 degrees F for grease tight construction.

I. Transfer Air and Sound Boots: 1/2 inch w.g. pressure class, galvanized steel.

2.02 MATERIALS

A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.

B. Stainless Steel for Ducts: ASTM A666, Type 304.

C. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
2. VOC Content: Not more than 250 g/L, excluding water.
3. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
4. For Use With Flexible Ducts: UL labeled.
5. Manufacturers:
    a. Carlisle HVAC Products; Hardcast Iron-Grip 601 Water Based Duct Sealant:

D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

E. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:

2.03 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.

B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.

D. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

F. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

2.04 MANUFACTURED DUCTWORK AND FITTINGS

A. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
1. Manufacture in accordance with SMACNA (DCS).
2. Manufacturers:
    a. EHG, a DMI Company
    b. GSI, a DMI Company

c. Linx Industries, Inc, a DMI Company
d. MKT Metal Manufacturing

B. Round Ducts: Round lockseam duct with galvanized steel outer wall.
1. Manufacture in accordance with SMACNA (DCS).
2. Manufacturers:
a. EHG, a DMI Company
b. Linx Industries, Inc, a DMI Company
c. MKT Metal Manufacturing

C. Flexible Ducts: Two ply vinyl film supported by helically wound spring steel wire.
1. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
2. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
3. Maximum Velocity: 4000 fpm.
4. Temperature Range: Minus 10 degrees F to 160 degrees F.
5. Manufacturers:
a. Hart & Cooley, Inc
b. JP Lamborn Co

D. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
1. Manufacturers:
a. Carlisle HVAC Products
b. Ductmate Industries, Inc, a DMI Company
c. Elgen Manufacturing
d. MKT Metal Manufacturing

E. Round Duct Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).

F. Kitchen Cooking Hood and Grease Exhaust: Nominal 3 inches thick ceramic fiber insulation between 20 gage, 0.0375 inch, Type 304 stainless steel liner and 24 gage, 0.0239 inch aluminized steel sheet outer jacket.
1. Tested and UL listed for use with commercial cooking equipment in accordance with NFPA 96.
2. Certified for zero clearance to combustible material in accordance with:
a. UL 2221 with a 2 hour rating.
3. Materials and construction of the modular sections and accessories to be in accordance with the terms of the following listings:
a. UL 2221.
4. Manufacturers:
a. AMPCO by Hart & Cooley, Inc.; Z-Clear
b. DuraVent; DuraZDuct (DIS3Z)
c. Security Chimneys International; Secure Duct (CIX3Z)
d. Selkirk Corporation; ZeroClear (IPS-Z3)

G. Dishwasher Exhaust: Minimum 21 gage, 0.0344 inch thick, single wall, Type 304 stainless steel.
1. Single wall, factory built general use vent system.
2. Designed, fabricated, and installed to be liquid tight preventing exhaust leakage into the building.
3. Joints to be sealed during installation with factory supplied overlapping V-bands and sealant.
4. Manufacturers:

a. AMPCO by Hart & Cooley, Inc.; Model N
b. Selkirk Corporation; Model G

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

C. Flexible Ducts: Connect to metal ducts with draw bands.

D. Kitchen Hood Exhaust: Provide residue traps at base of vertical risers with provisions for clean out.

E. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

G. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.

H. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.

END OF SECTION

SECTION 23 3300
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Air turning devices/extractors.

B. Backdraft dampers - metal.

C. Combination fire and smoke dampers.

D. Duct access doors.

E. Fire dampers.

F. Flexible duct connections.

G. Volume control dampers.

H. Miscellaneous products:
   1. Duct opening closure film.

1.03 RELATED REQUIREMENTS

A. Section 23 3100 - HVAC Ducts and Casings.

1.04 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

B. NFPA 92 - Standard for Smoke Control Systems.

C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

D. UL 33 - Safety Heat Responsive Links for Fire-Protection Service.

E. UL 555 - Standard for Fire Dampers.

F. UL 555S - Standard for Smoke Dampers.

1.05 SUBMITTALS

A. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.

B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

A. Manufacturers:
   1. Carlisle HVAC Products
   2. Elgen Manufacturing, Inc
   3. Krueger-HVAC, Division of Air System Components
   4. Ruskin Company, a brand of Johnson Controls
   5. Titus HVAC, a brand of Johnson Controls
   6. Ward Industries, a brand of Hart and Cooley, Inc

B. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS - METAL

A. Manufacturers:
   1. Louvers & Dampers, Inc, a brand of Mestek, Inc.
   2. Nailor Industries, Inc
   3. Ruskin Company, a brand of Johnson Controls

B. Gravity Backdraft Dampers, Size 18 by 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

2.03 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
   1. AireTechnologies, Inc, a DMI Company
   2. Louvers & Dampers, Inc, a brand of Mestek, Inc
   3. Nailor Industries, Inc
   4. NCA, a brand of Metal Industries Inc
   5. Ruskin Company

B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.

C. Provide factory sleeve and collar for each damper.

D. Multiple Blade Dampers: Fabricate with 16 gage, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.

E. Operators: UL listed and labelled spring return electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on exterior of duct and link to damper operating shaft.

F. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.

G. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.04 DUCT ACCESS DOORS

A. Manufacturers:
   1. Nailor Industries, Inc
   2. Ruskin Company, a brand of Johnson Controls
   3. SEMCO LLC
   4. Ward Industries, a brand of Hart and Cooley, Inc

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Access doors with sheet metal screw fasteners are not acceptable.

2.05 FIRE DAMPERS

A. Manufacturers:
   1. Nailor Industries, Inc
   2. Ruskin Company, a brand of Johnson Controls
   3. Ward Industries, a brand of Hart and Cooley, Inc

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.

D. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.06 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:
   1. Carlisle HVAC Products
   2. Elgen Manufacturing, Inc

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Flexible Duct Connections: Fabric crimped into metal edging strip.
   1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
      a. Net Fabric Width: Approximately 2 inches wide.
   2. Metal: 3 inches wide, 24 gage, 0.0239 inch thick galvanized steel.

D. Maximum Installed Length: 6 inch.

2.07 VOLUME CONTROL DAMPERS

A. Manufacturers:
   1. Louvers & Dampers, Inc, a brand of Mestek, Inc
   2. Nailor Industries, Inc
   3. NCA, a brand of Metal Industries Inc
   4. Ruskin Company, a brand of Johnson Controls

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Single Blade Dampers:
   1. Fabricate for duct sizes up to 6 by 30 inch.
   2. Blade: 24 gage, 0.0239 inch, minimum.

D. Quadrants:
   1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
   2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
   3. Where rod lengths exceed 30 inches provide regulator at both ends.

2.08 MISCELLANEOUS PRODUCTS

A. Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
   1. Thickness: 2 mils.
   2. High tack water based adhesive.
   3. UV stable light blue color.
   4. Elongation Before Break: 325 percent, minimum.
   5. Manufacturers:
      a. Carlisle HVAC Products

PART 3 EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 3100 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide fire dampers and combination fire and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

D. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.

E. Demonstrate re-setting of fire dampers to Owner's representative.

F. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

G. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

I. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly or shown on the plans.

END OF SECTION

SECTION 23 3423
HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Roof exhausters.

B. Roof ventilators.

C. Cabinet exhaust fans.

D. Upblast roof exhausters.

E. Kitchen hood upblast roof exhausters.

1.03 REFERENCE STANDARDS

A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program.

B. AMCA 99 - Standards Handbook.

C. AMCA 204 - Balance Quality and Vibration Levels for Fans.

D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.

E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

G. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.

1.05 FIELD CONDITIONS

A. Permanent ventilators may not be used for ventilation during construction.

PART 2 PRODUCTS

2.01 POWER VENTILATORS - GENERAL

A. Manufacturers:
   1. Carnes, a division of Carnes Company Inc
   2. Greenheck Fan Corporation
   3. PennBarry, Division of Air System Components

B. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.

C. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.

D. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.

E. Fabrication: Conform to AMCA 99.

F. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.02 ROOF VENTILATORS

A. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.

B. Roof Curb: 12 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.

C. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.

D. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.

E. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.03 UPBLAST ROOF EXHAUSTERS

A. Manufacturers:
   1. Carnes, a division of Carnes Company Inc
   2. Greenheck Fan Corporation
   3. PennBarry, Division of Air System Components

B. Direct Drive Fan:
   1. Fan Wheel:
      a. Type: Non-overloading, backward inclined centrifugal.
      b. Material: Aluminum.
   2. Statically and dynamically balanced.
   3. Motors:
      a. Open drip-proof (ODP).
      b. Heavy duty ball bearing type.
      c. Mount on vibration isolators or resilient cradle mounts, out of air stream.
      d. Fully accessible for maintenance.
   4. Housing:
      a. Construct of heavy gage aluminum including curb cap, windband, and motor compartment.
      b. Rigid internal support structure.
      c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
      d. Construct drive frame assembly of heavy gage steel, mounted on vibration isolators.
      e. Provide breather tube for fresh air motor cooling and wiring.

C. Shafts and Bearings:
   1. Fan Shaft:
      a. Ground and polished steel with anti-corrosive coating.
      b. First critical speed at least 25 percent over maximum cataloged operating speed.
   2. Bearings:
      a. Permanently sealed or pillow block type.
      b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
      c. 100 percent factory tested.

D. Drive Assembly:
   1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
   2. Belts: Static free and oil resistant.
   3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
   4. Motor pulley adjustable for final system balancing.
   5. Readily accessible for maintenance.

E. Roof Curb: 12 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips and insulation and curb bottom.

F. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

2.04 KITCHEN HOOD UPBLAST ROOF EXHAUSTERS

A. Manufacturers:
   1. Carnes, a division of Carnes Company Inc: www.carnes.com/#sle.
   2. Greenheck Fan Corporation
   3. PennBarry, Division of Air System Components
   4. Twin City Fan & Blower

B. Belt Drive Fan:
   1. Fan Wheel:
      a. Type: Non-overloading, backward inclined centrifugal.
      b. Material: Aluminum.
   2. Statically and dynamically balanced.
   3. Motors:
      a. Open drip-proof (ODP).
      b. Heavy duty ball bearing type.
      c. Mount on vibration isolators or resilient cradle mounts, out of air stream.
      d. Fully accessible for maintenance.
   4. Housing:
      a. Construct of heavy gage aluminum including curb cap, windband, and motor compartment.
      b. Rigid internal support structure.
      c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
      d. Construct drive frame assembly of heavy gage steel, mounted on vibration isolators.
      e. Provide breather tube for fresh air motor cooling and wiring.

C. Shafts and Bearings:
   1. Fan Shaft:
      a. Ground and polished steel with anti-corrosive coating.
      b. First critical speed at least 25 percent over maximum cataloged operating speed.
   2. Bearings:
      a. Permanently sealed or pillow block type.
      b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
      c. 100 percent factory tested.

D. Drive Assembly:
   1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
   2. Belts: Static free and oil resistant.
   3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
   4. Motor pulley adjustable for final system balancing.
   5. Readily accessible for maintenance.

E. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

F. Options/Accessories:
   1. Clean Out Port: Removable grease repellent compression rubber plug allows access for cleaning wheel through windband.
   2. Roof Curb Extension: Vented curb extension where required for compliance with minimum clearances required by NFPA 96.
   3. Drain Connection:
      a. Aluminum construction.
      b. Allows single-point drainage of grease, water, or other residues.
   4. Finishes: Standard factory finish.
   5. Grease Trap:
      a. Aluminum.
      b. Includes drain connection.
      c. Collects grease residue.
   6. Hinge Kit:
      a. Hinges and restraint cables mounted to base (sleeve).
      b. Allows fan to tilt away for access to wheel and ductwork for inspection and cleaning.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.

C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.

D. Hung Cabinet Fans:
   1. Install fans with resilient mountings and flexible electrical leads. Refer to Section 22 0548.
   2. Install flexible connections specified in Section 23 3300 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

E. Install backdraft dampers on inlet to roof and wall exhausters.

F. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

END OF SECTION

SECTION 23 3600
AIR TERMINAL UNITS

PART 1 GENERAL

1.01 RELATED

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Single-duct terminal units.
   1. Single-duct, variable-volume units.

B. Fan-powered units.

1.03 RELATED REQUIREMENTS

A. Section 23 0548 - Vibration and Seismic Controls for HVAC.

B. Section 23 3100 - HVAC Ducts and Casings.

1.04 REFERENCE STANDARDS

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.

B. AHRI 880 (I-P) - Performance Rating of Air Terminals.

C. ASTM A492 - Standard Specification for Stainless Steel Rope Wire.

D. ASTM A603 - Standard Specification for Metallic-Coated Steel Structural Wire Rope.

E. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

F. NFPA 70 - National Electrical Code.

G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

H. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems.

1.05 SUBMITTALS

A. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.

B. Certificates: Certify that air coil capacities, pressure drops, and selection procedures meet or exceed specified requirements.

C. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.

D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 WARRANTY

A. Provide five year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.01 SINGLE-DUCT, VARIABLE-VOLUME UNITS

A. Manufacturers:
   1. Krueger-HVAC
   2. Price Industries, Inc
   3. Titus
   4. Nailor

B. General:
   1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
   2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil (right or left hand) connection, where applicable.

C. Unit Casing:
   1. Minimum 22 gage, 0.0299 inch galvanized steel.
   2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
   3. Unit Discharge: Rectangular, with slip-and-drive connections.
   4. Acceptable Liners:
      a. 1 inch thick, coated, fibrous-glass complying with ASTM C1071.
         1) Secure with adhesive.
         2) Coat edges exposed to airstream with NFPA 90A approved sealant.
         3) Cover liner with non-porous foil.
      b. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.

D. Damper Assembly:
   1. Heavy-gage, galvanized steel or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.
   2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
   3. Incorporate low leak damper blades for tight airflow shutoff.

E. Hot Water Heating Coil:
   1. Coil Casing: Minimum 22 gage, 0.0299 inch galvanized steel, factory-installed on terminal discharge with rectangular outlet, duct connection type.
   2. Coil Fins: Aluminum or aluminum plated fins, mechanically-bonded to seamless copper tubes.
   3. Coil leak tested to minimum 350 psig.
   4. Base performance data on tests run in accordance with AHRI 410 and units to bear AHRI 410 label.

F. Electrical Requirements:
   1. Single-point power connection.
   2. Equipment wiring to comply with requirements of NFPA 70.

G. Control Transformers: Factory supplied and mounted for electric and electronic control applications.

H. Controls:
   1. DDC (Direct-Digital Controls):
      a. Include a factory-installed, unit-mounted or field-installed, factory-tested, direct-digital controller.
      b. Bi-directional Damper Actuator: 24 volt, powered closed, spring return open.
      c. Microprocessor-Based Controller: Air volume controller, pressure-independent with electronic airflow transducers, factory-calibrated maximum and minimum CFM's.
         1) Occupied and unoccupied operating mode.
         2) Remote reset of temperature or CFM set points.
         3) Proportional, plus integral control of room temperature.
         4) Monitoring and adjusting with portable terminal.
         5) Time-proportional reheat coil control.

d. Room Sensor:
    1) Compatible with temperature controls specified.
    2) Wall-mounted, system powered, with temperature set-point adjustment including connection access for portable operator terminal.
2. Airflow Sensor: Differential pressure airflow device measuring total, static, and wake pressures.
    a. Signal accuracy: Plus/minus five percent throughout terminal operating range.
3. Control Sequence:
    a. Suitable for operation with duct pressures between 0.25 and 3.0 inch wg inlet static pressure.
    b. Include factory-mounted and piped, 5-micron filter; and adjustable, velocity-resetting, high-limit control with amplifying relay.

2.02 HOSE KITS AND VALVES

A. Manufacturers:
1. Griswold Controls
2. Hays Fluid Controls
3. IMI Flow Design, a brand of IMI Hydronic Engineering Division of IMI plc

B. Hoses:
1. Provide hoses for all units for connection to main water supply and return headers.
2. Length: 1 feet.
3. Material: Braided stainless steel rated to minimum 400 psi at 265 degrees F.

C. Manual Balancing Valves:
1. Brass body for shutoff and hydronic balancing.

D. Ball Valves:
1. Brass body for shutoff and hydronic balancing.
2. Provide pressure/temperature ports.
3. Provide balancing valves.

E. Y Strainers:
1. Bronze body.
2. "Y" type configuration with brass cap.
3. Maximum Operating Pressure: Minimum 450 psi.
4. Screen: Stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are suitable for installation.

B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.

C. See drawings for the size(s) and duct location(s) of the air terminal units.

D. Provide ceiling access doors or locate units above easily removable ceiling components.

E. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 23 0548.

F. Do not support from ductwork.

G. Connect to ductwork in accordance with Section 23 3100.

3.03 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow. Set units with heating coils for minimum 35 percent full flow.

END OF SECTION

SECTION 23 3700
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Diffusers.

B. Security diffusers.

C. Registers/grilles.

D. Security grilles.

E. Louvers.

F. Louvered penthouses.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets.

1.04 SUBMITTALS

A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.05 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Hart & Cooley, Inc

B. Krueger-HVAC.

C. Price Industries

D. Titus, a brand of Air Distribution Technologies

E. KEES

2.02 RECTANGULAR CEILING DIFFUSERS

A. Type: Provide plaque face diffuser to discharge air in four way pattern.

B. Connections: Round.

C. Frame: Provide surface mount type.

D. Fabrication: Steel with baked enamel finish.

E. Color: As selected by Architect from manufacturer's standard range.

2.03 PERFORATED FACE CEILING DIFFUSERS

A. Frame: Surface mount type.

B. Fabrication: Steel with steel frame and baked enamel finish.

C. Color: As selected by Architect from manufacturer's standard range.

2.04 CEILING SLOT DIFFUSERS

A. Type: Continuous 1-1/2 inch wide slot, two slots wide, with adjustable vanes for left, right, or vertical discharge.

B. Fabrication: Aluminum extrusions with factory baked enamel finish.

C. Color: To be selected by Architect from manufacturer's standard range.

D. Frame: 1-1/4 inch margin with support clips for T bar mounting and gasket, mitered end border.

E. Plenum: Integral, galvanized steel, insulated.

2.05 SECURITY DIFFUSERS

A. 14 ga. steel face plate having 3/16" dia. holes on 1/4" staggered centers, commercial ceiling diffuser, countersunk screw holes 10” o.c., and #10 x 2” Torx security sheet metal screws.

B. Face operable opposed blade dampers ship loose for field installation.

C. Complies with NIC recommendations and California BoP Title 24.

2.06 CEILING SUPPLY REGISTERS/GRILLES

A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, two-way deflection.

B. Frame: 1-1/4 inch margin with concealed mounting and gasket.

C. Construction: Made of aluminum extrusions with factory enamel finish.

D. Color: As selected by Architect from manufacturer's standard range.

2.07 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical face.

B. Frame: 1-1/4 inch margin with concealed mounting.

C. Fabrication: Steel with 20 gage, 0.0359 inch minimum frames and 22 gage, 0.0299 inch minimum blades, steel and aluminum with 20 gage, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.

D. Color: To be selected by Architect from manufacturer's standard range.

2.08 CEILING LINEAR EXHAUST AND RETURN GRILLES

A. Type: Streamlined blades with 90 degree two-way deflection, 1/8 by 3/4 inch on 1/4 inch centers.

B. Frame: 1-1/4 inch margin with concealed mounting.

C. Fabrication: Steel with 20 gage, 0.0359 inch minimum frames and 22 gage, 0.0299 inch minimum blades, steel and aluminum with 20 gage, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.

D. Color: To be selected by Architect from manufacturer's standard range.

2.09 SECURITY GRILLES

A. 10 ga. steel flange and 11 ga. perforated face having 1/8" dia. holes on 3/16" staggered centers.

B. Sleeves are 10 ga. steel, 12" long with rear operable opposed blade damper .

C. White finish.

D. Loose 1" x 1" x 3/16" unpainted steel angle frame for field welding to sleeve

E. Complies with NIC recommendations and California BoP Title 24.

2.10 WALL SUPPLY REGISTERS/GRILLES

A. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, single deflection.

B. Frame: 1-1/4 inch margin with concealed mounting and gasket.

C. Fabrication: Steel with 20 gage, 0.0359 inch minimum frames and 22 gage, 0.0299 inch minimum blades, steel and aluminum with 20 gage, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.

D. Color: To be selected by Architect from manufacturer's standard range.

2.11 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical face.

B. Frame: 1-1/4 inch margin with concealed mounting.

C. Fabrication: Steel frames and blades, with factory baked enamel finish.

D. Color: To be selected by Architect from manufacturer's standard range.

2.12 LINEAR WALL REGISTERS/GRILLES

A. Manufacturers:

B. Type: Streamlined blades with 0 or 30 (as indicated) degree deflection, 1/8 by 3/4 inch on 1/4 inch centers.

C. Frame: 1-1/4 inch margin with concealed mounting and gasket.

D. Fabrication: Aluminum extrusions, with factory baked enamel finish.

E. Color: To be selected by Architect from manufacturer's standard range.

2.13 LOUVERS

A. Manufacturers:
   1. NCA, a brand of Metal Industries Inc
   2. Ruskin Company

B. Type: 6 inch deep with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over exhaust and 1/2 inch square mesh screen over intake.

C. Fabrication: 16 gage, 0.0598 inch thick galvanized steel welded assembly, with factory prime coat finish.

D. Color: To be selected by Architect from manufacturer's standard range.

E. Fabrication: 12 gage, 0.1046 inch thick extruded aluminum, welded assembly, with factory prime coat finish.

F. Mounting: Furnish with exterior flat flange for installation.

2.14 COMBINATION LOUVERS

A. Manufacturers:
   1. Ruskin Company

B. Type: 6 inch deep with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over exhaust and 1/2 inch square mesh screen over intake.

C. Color: To be selected by Architect from manufacturer's standard range.

D. Fabrication: 12 gage, 0.1046 inch thick extruded aluminum, welded assembly, with factory prime coat finish.

E. Color: To be selected by Architect from manufacturer's standard range.

F. Mounting: Furnish with exterior flat flange for installation.

2.15 LOUVERED PENTHOUSES

A. Manufacturers:
   1. Ruskin Company
   2. Greenheck.

B. Type: All welded assembly with 4 inch deep louvers, mitered corners, sheet aluminum roof, with factory baked enamel finish.

C. Color: To be selected by Architect from manufacturer's standard range.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9123.

END OF SECTION

SECTION 23 5100
BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Single wall metal stacks.

1.03 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

1.04 REFERENCE STANDARDS

A. NFPA 54 - National Fuel Gas Code.

B. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment.

C. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.

D. UL 103 - Factory-Built Chimneys for Residential Type and Building Heating Appliances.

1.05 SUBMITTALS

A. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.

PART 2 PRODUCTS

2.01 BREECHINGS, CHIMNEYS, AND STACKS - GENERAL REQUIREMENTS

A. Regulatory Requirements:
   1. Comply with applicable codes for installation of natural gas burning appliances and equipment.
   2. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.02 SINGLE WALL METAL STACKS

A. Manufacturers:
   1. Z-Flex U.S. Inc; Z-VENT Single Wall
   2. Heat Fab, Inc; Saf-T-Vent.
   3. Dura-Vent; FasNSeaL.
   4. Metal-Fab, Inc; CORR/GUARD

B. Provide single wall metal stacks, tested to UL 103 and UL listed with positive pressure rating, for use with building heating equipment, in compliance with NFPA 211.

C. Fabricate with AL29-4C stainless steel.
   1. Protect aluminized steel surfaces exposed to the elements with a minimum of one base coat of primer and one finish coat of corrosion resistant paint suitable for outer jacket skin temperatures of the application.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 54

C. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.

D. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.

E. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

F. Assemble and install stack sections in accordance with NFPA 82, industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement. Connect base section to foundation using anchor lugs.

G. Level and plumb chimney and stacks.

H. Clean breechings, chimneys, and stacks during installation, removing dust and debris.

I. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breechings, breeching insulation, chimneys, or stacks.

END OF SECTION

SECTION 23 5216
CONDENSING BOILERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Manufactured units.

B. Boiler construction.

C. Boiler trim.

D. Fuel burning system.

E. Factory installed controls.

1.03 RELATED REQUIREMENTS

A. Section 23 0913 - Instrumentation and Control Devices for HVAC.

B. Section 23 2114 - Hydronic Specialties.

C. Section 23 2123 - Hydronic Pumps.

D. Section 23 2500 - HVAC Water Treatment.

E. Section 23 5100 - Breechings, Chimneys, and Stacks.

F. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.04 REFERENCE STANDARDS

A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).

B. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers.

D. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI).

E. NFPA 54 - National Fuel Gas Code.

F. SCAQMD 1146.1 - Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters.

1.05 SUBMITTALS

A. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.

B. Manufacturer's Factory Inspection Report: Submit boiler inspection prior to shipment.

C. Manufacturer's Field Reports: Burner manifold gas pressure, percent carbon monoxide (CO), percent oxygen (O), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output.
   1. Indicate compliance with specified performance and efficiency.

D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

1.07 WARRANTY

A. Provide a five year warranty to include coverage for heat exchanger.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Natural Gas, Propane, or Combination Natural Gas/Propane for Indoor Applications:
   1. Cleaver Brooks.
   2. Viessmann.
   3. HTP.
   4. Raypak.

2.02 MANUFACTURED UNITS

A. Factory assembled, factory fire-tested, self-contained, readily transported unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.

B. Unit: Metal membrane wall, water or fire tube, condensing boiler on integral structural steel frame base with integral fuel burning system, firing controls, boiler trim, insulation, and removable jacket, suitable for indoor application.

2.03 BOILER CONSTRUCTION

A. Comply with the minimum requirements of ASME BPVC-IV and ANSI Z21.13 for construction of boilers.

B. Assembly to bear the ASME "H" stamp and comply with the efficiency requirements of the latest edition of ASHRAE Std 90.1 I-P.

C. Required Directory Listings:
   1. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
   2. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI).

D. Heat Exchanger: Construct with materials that are impervious to corrosion where subject to contact with corrosive condensables.

E. Provide adequate tappings, observation ports, removable panels, and access doors for entry, cleaning, and inspection.

F. Insulate casing with insulation material, protected and covered by heavy-gage metal jacket.

G. Factory apply boiler base and other components, that are subject to corrosion, with durable, powder coated finish.

2.04 BOILER TRIM

A. ASME rated pressure relief valve.

B. Flow switch.

C. Electronic Low Water Cut-off: Complete with test light and manual reset button to automatically prevent firing operation whenever boiler water falls below safe level.

D. Temperature and pressure gauge.

E. Pressure Switches:
   1. High gas pressure.
   2. Low gas pressure.
   3. Air pressure.

F. Manual reset high limit.

G. Boiler Pump (where required by boiler design):
   1. Primary pump, factory supplied and sized for field installation to ensure minimum, continuous circulation through boiler.
   2. Where pump is not provided by boiler manufacturer, provide pump in accordance with boiler manufacturer's recommendations.
   3. Pump time delay.

2.05 FUEL BURNING SYSTEM

A. Provide forced draft automatic burner, integral to boiler, designed to burn natural gas, and maintain fuel-air ratios automatically.
   1. Combustion Air Filter: Protects fuel burning system from debris.

B. Gas Train: Plug valve, safety gas valve, gas-air ratio control valve, and pressure regulator controls air and gas mixture.

C. Emission of Oxides of Nitrogen Requirements: Comply with SCAQMD 1146.1 for natural gas fired system, as applicable.

D. Intakes: Combustion air intake capable of accepting free mechanical room air or direct outside air through a sealed intake pipe.

2.06 FACTORY INSTALLED CONTROLS

A. Option for internal or external (0-10) VDC control.

B. Temperature Controls:
   1. Automatic reset type to control fuel burning system on-off and firing rate to maintain temperature.
   2. Manual reset type to control fuel burning system to prevent boiler water temperature from exceeding safe system water temperature.
   3. Low-fire start time delay relay.

C. Electronic PI setpoint/modulation control system.

D. Microprocessor-based, fuel/air mixing controls.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install boiler and provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.

C. Coordinate factory installed controls with Section 23 0923.

D. Coordinate provisions for water treatment in accordance with Section 23 2500.

E. Pipe relief valves to nearest floor drain.

F. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.

G. Install primary boiler pump in accordance with Section 23 2123.

H. Provide piping connection and accessories in accordance with Section 23 2114.

I. Provide for connection to electrical service in accordance with Section 26 0583.

J. Vent combustion air and combustion fumes in accordance with manufacturer's recommendations.

3.02 CLOSEOUT ACTIVITIES

A. Demonstrate proper operation of equipment to Owner's designated representative.

B. Demonstration: Demonstrate operation of system to Owner's personnel.
   1. Use operation and maintenance data as reference during demonstration.
   2. Conduct walking tour of project.
   3. Briefly describe function, operation, and maintenance of each component.

C. Training: Train Owner's personnel on operation and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.

END OF SECTION

SECTION 23 7223
PACKAGED AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Energy recovery units.

B. Casing.

C. Fans.

D. Total energy wheel.

E. Filters.

F. Dampers.

G. Vibration isolation.

H. Roof curbs.

I. Power and controls.

J. Accessories.

K. Service accessories.

1.03 REFERENCE STANDARDS

A. AHRI 1060 I-P - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment.

B. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

C. ASHRAE Std 84 - Method of Testing Air to Air Heat/Energy Exchangers.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

E. NFPA 70 - National Electrical Code.

F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

G. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

A. Product Data: Manufacturer's installation instruction, product data, and engineering calculations.

1.05 WARRANTY

A. Warranty energy recovery wheel to be free from defects in material and workmanship for 3 years under circumstances of normal use.

B. Warranty motor to be free from defects in material and workmanship for 7 years under circumstances of normal use.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Energy Recovery Ventilators:
   1. RenewAire
   2. Ruskin Company

3. Semco Inc
4. Greenheck.

2.02 ENERGY RECOVERY UNITS

A. Energy Recovery Units: Provide dessicant wheel type air-to-air exchanger; prefabricated packaged system designed by manufacturer.
   1. Provide unit with a AHRI 1060 I-P compliant air-to-air exchanger.
   2. Access: Hinged and/or screwed access panels on front.
   3. Lifting holes at the unit base.
   4. Framing: Welded extruded aluminum tubular frame capable of supporting components and casings.
   5. Permanent name plate listing manufacturer mounted inside door near electrical panel.

2.03 CASING

A. Wall, Floor, and Roof Panels:
   1. Panels: Removable.
   2. Construction: 1 inch thick, double wall box construction, with formed edges of exterior wall overlapping formed edges of interior wall.
   3. Exterior Wall: Galvanized steel sheet.
      a. 0.040 inches thick aluminum.
   4. Interior Wall: Galvanized sheet metal.
      a. 22 gauge, 0.0299 inch galvanized sheet metal.
   5. Insulation:
      a. 1 inch insulated fiberglass.
      b. Panel Cores: Mineral wool board.
      c. Flame Spread Index (FSI): 25 or less, when tested in accordance with ASTM E84 or UL 723.
      d. Smoke Developed Index (SDI): 50, maximum, when tested in accordance with ASTM E84 or UL 723.
   6. Roof Panel: Weatherproof.
   7. Coating: Polyurethane enamel.

B. Access Panels: Provide access to components through a large, tightly sealed and easily removable panel.

C. Doors:
   1. Construct doors of same construction and thickness as wall panels.
   2. Height: 80 inches.
   3. Hardware:
      a. Hinges: Aluminum.

2.04 FANS

A. Provide separate fans for exhaust and supply blowers.

B. Fans:
   1. Individually driven with a dedicated motor.
   2. Provide with non-overloading characteristics.

C. Housings: 12 gauge, 0.1046 inch aluminized steel with plenums integral to general housing and constructed to Class 1 fan standards.

D. Motors:
   1. Motors: Open drip proof.
   2. Efficiency: High.
   3. Speed: Single.

4. Control: Variable Frequency Drive.
5. Fan Motor: UL listed and labeled.

E. Drives:
1. Fans: Belt driven.

2.05 TOTAL ENERGY WHEEL

A. Wheel: Transfer heat and humidity from one air stream to the other with minimum carryover of the exhaust air into the supply air stream.

B. Energy Wheel Media: Cleanable with low temperature steam, hot water or light detergent, without degrading the latent recovery.

C. Wheel Effectiveness: Rated in accordance with ASHRAE Std 84 and AHRI 1060 I-P.

D. Flame Spread Index (FSI): 25 or less, when tested in accordance with ASTM E84 or UL 723.

E. Smoke Developed Index (SDI): 50 or less, when tested in accordance with ASTM E84 or UL 723.

F. Energy Recovery Wheel Media Face:
1. Comply with NFPA 90A.

G. Wheel Cassette: Easily removable from the unit.

H. Rotor:
1. Type: Non-segmented hygroscopic aluminum wheel.
2. Rotor Matrix: Corrosion resistant aluminum alloy composed of alternating corrugated and flat, continuously wound layers of uniform widths.

I. Drive:
1. Drive: Tensioned drive with full perimeter link style belt.

J. Wheel Rotation Detection:
1. Send alarm to Building Management System if rotation is not detected or belt is slipping.

2.06 FILTERS

A. Thickness: 2 inch.

B. Efficiency: MERV 13.

C. Exhaust and Fresh Air Streams: MERV 7 filters constructed to meet ASHRAE Std 52.2.

D. Mount 1/2 inches thick permanent aluminum washable type filter in the outside air hood and in the return plenum air.

2.07 DAMPERS

A. Motorized Dampers: Provide motorized dampers at outside air inlet and exhaust air outlet
1. Type: Motorized two position parallel blade damper with blade seals.
2. Motorized Damper: Roll-formed structural hat channels, reinforced at the corners,
3. Blades: Single skin, 16 gauge, 0.0598 inch.

2.08 ROOF CURBS

A. Curbs: Provide full perimeter roof curb fabricated from 10 gauge, 0.1345 inch aluminized steel.

2.09 POWER AND CONTROLS

A. Motor Control Panels: UL listed.

B. Include necessary motor starters, fuses, transformers and overload protection according to NFPA 70.

C. Provide single-point field connection to power supply.

D. Install wiring in accordance with NFPA 70.

2.10 ACCESSORIES

A. Rotation Detector:
   1. Equip unit with rotation sensor.
   2. Equip controller with outdoor air temperature sensor that stops energy recovery wheel during moderate temperature periods.

2.11 SERVICE ACCESSORIES

A. Electrical Receptacle:
   1. Provide duplex, ground fault interrupter type receptacle.

B. Electrical Components: Factory wired for single point power connection.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that structure is ready for installation of unit, that openings in deck for ductwork, if required, are correctly sized and located, and that mechanical and electrical utilities supplying unit are of correct capacities and are accessible.

3.02 INSTALLATION

A. Provide openings for suitable ductwork connection.

B. Outdoor Installations:
   1. Roof Panels:
      a. Fasteners: Use concealed means of attachment.
      b. Minimize penetrations through roof.
      c. Provide weather tight seal at required penetrations.

3.03 SYSTEM STARTUP

END OF SECTION

SECTION 23 7413
PACKAGED OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.01 RELATRED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Packaged roof top unit.

B. Unit controls.

C. Roof mounting curb and base.

D. Maintenance service.

1.03 RELATED REQUIREMENTS

A. Section 23 0548 - Vibration and Seismic Controls for HVAC.

1.04 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.05 SUBMITTALS

A. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

B. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

D. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing off site until roof mounting curbs are in place, ready for immediate installation of units.

1.07 WARRANTY

A. Provide a five year warranty to include coverage for refrigeration compressors.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Daikin

B. AAON

2.02 MANUFACTURED UNITS

A. General: Roof mounted units having gas burner and electric refrigeration.

B. Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, heat exchanger and burner, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.

C. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.03 FABRICATION

A. Cabinet: Steel with baked enamel finish, including access panels with screwdriver operated flush cam type fasteners. Structural members shall be minimum 18 gage, 0.0478 inch, with access doors or panels of minimum 20 gage, 0.0359 inch.

B. Insulation: 2 inch thick neoprene coated glass fiber with edges protected from erosion.

C. Supply and Return Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, and rubber isolated hinge mounted high efficiency motor or direct drive as indicated. Isolate complete fan assembly. Refer to Section 23 0548.

D. Air Filters:
   1. 2 inch thick glass fiber disposable media in metal frames.

2.04 BURNER

A. Gas Burner: Atmospheric type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shut-off pilot.

B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after air flow proven and slight delay, allow gas valve to open.

C. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature and energize burner when temperature drops to lower safe value.

D. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, with provisions for continuous fan operation.

2.05 EVAPORATOR COIL

A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.

B. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

2.06 COMPRESSOR

A. Provide hermetic compressors, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.

B. Provide step capacity control by cycling multi-speed compressors.

2.07 CONDENSER COIL

A. Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.

B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.

2.08 MIXED AIR CASING

A. Dampers: Provide outside, return, and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper to fall to closed position. Relief dampers may be gravity balanced.

B. Gaskets: Provide tight fitting dampers with edge gaskets maximum leakage 5 percent at 2 inches pressure differential.

C. Damper Operator, Units 7.5 Ton Cooling Capacity and Larger: 24 volt with gear train sealed in oil with spring return on.

D. Mixed Air Controls: Maintain selected supply air temperature and return dampers to minimum position on call for heating and above 75 degrees F ambient, or when ambient air temperature exceeds return air temperature.

2.09 OPERATING CONTROLS

A. Provide remote readout panels containing signal lights indicating system status, heating system failure, cooling system failure, and dirty filters; check switches proving signal light operations; system on-off switch, and cooling system on-off switch.

2.10 OPERATING CONTROLS - SINGLE ZONE UNITS

A. Electric solid state microcomputer based room thermostat, located as indicated in service area with remote sensor located as indicated.

B. Room thermostat shall incorporate:
   1. Automatic switching from heating to cooling.
   2. Preferential rate control to minimize overshoot and deviation from set point.
   3. Instant override of set point for continuous or timed period from one hour to 31 days.
   4. Programming based on weekdays, Saturday and Sunday.
   5. Switch selection features including imperial or metric display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.

C. Room thermostat display shall include:
   1. Time of day.
   2. Actual room temperature.
   3. Programmed temperature.
   4. Programmed time.
   5. Duration of timed override.
   6. Day of week.
   7. System model indication: heating, cooling, auto, off, fan auto, fan on.
   8. Stage (heating or cooling) operation.

2.11 OPERATING CONTROLS - VARIABLE VOLUME UNITS

A. Temperature transmitter located in supply air shall signal electronic logic panel to control mixing dampers and cooling in sequence. Mixing section shall operate as first stage of cooling and revert to minimum outside air above approximately 75 degrees F as determined by enthalpy of return and outdoor air.

B. Control cooling by cycling compressors, cylinder unloading, and hot gas bypass.

C. Control logic shall allow supply air reset under low load or airflow conditions.

D. Seven day time clock with spring carry over (or electronic clock with battery backup) shall control unit on occupied/un-occupied schedule. At night, unit shall be off. Locate clock in remote control panel with status lights.

E. Provide two stage morning warm-up thermostat to hold outdoor dampers closed and energize heat until return air temperature reaches set point.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that proper power supply is available.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 90A.

C. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

D. Locate remote panels where indicated on drawings.

3.03 SYSTEM STARTUP

A. Prepare and start equipment. Adjust for proper operation.

3.04 CLOSEOUT ACTIVITIES

A. Demonstrate operation to Owner's maintenance personnel.

3.05 MAINTENANCE

A. Provide service and maintenance of packaged roof top units for one year year from Date of Substantial Completion.

B. Provide routine maintenance service with a two month interval as maximum time period between calls.

C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.

D. After each service call, submit copy of service call work order or report that includes description of work performed.

END OF SECTION

SECTION 23 8124
COMPUTER ROOM AIR CONDITIONERS - FLOOR MOUNTED

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air conditioning units.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide for manufactured products and assemblies. Indicate water, drain, refrigeration, rough-in connections, and electrical characteristics and connection requirements.

C. Shop Drawings: Indicate manufactured products and assemblies. Indicate water, drain, refrigeration, rough-in connections, and electrical characteristics and connection requirements.

D. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.03 WARRANTY

A. Warranty: Include coverage of refrigeration compressors.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. American Power Conversion Corporation

B. Compu-Aire, Inc

C. Liebert, a brand of Vertiv Co:

2.02 AIR CONDITIONING UNITS

A. Description: Packaged, air cooled, factory assembled, pre-wired and pre-piped unit, consisting of cabinet, fans, filters, humidifier, and controls.

B. Assembly: Up-flow air delivery, in draw-through configuration.

C. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.03 CABINET AND FRAME

A. Structural Frame: 10 gauge, 0.1345 inch welded steel suitably braced for rigidity, capable of supporting compressors and other mechanical equipment and fittings with welded tubular steel floor stand with adjustable legs and vibration isolation pads.

B. Doors and Access Panels: 18 gauge, 0.0478 inch galvanized steel with polyurethane gaskets, hinges to allow removal of panels, and concealed fastening devices.

C. Insulation: Thermally and acoustically line cabinet interior with 1 inch thick acoustic duct liner.

2.04 EVAPORATOR FANS AND MOTORS

A. Fans: Double inlet, forward curved centrifugal fans, statically and dynamically balanced, directly driven.

2.05 COMPRESSORS

2.06 EVAPORATOR COILS

A. Alternate row circuits, direct expansion cooling coils of seamless copper tubes expanded into aluminum fins in A-frame configuration.

B. Mount coil assembly in stainless steel drain pan.

2.07 CONDENSERS

A. Air Cooled Refrigerant Condenser:
   1. Corrosion resistant cabinet.
   2. Copper tube aluminum fin coils arranged for two circuits.
   3. Multiple direct drive propeller fans with permanently lubricated ball bearings.
   4. Single phase motors with internal overload protection.
   5. Provide capacity control by cycling fans.

2.08 FILTERS

A. Media: Pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded wire grid; enclosed in cardboard frame; 2 inch nominal thickness.

2.09 ELECTRICAL PANEL

2.10 ELECTRONIC CONTROL SYSTEM

A. Solid state with start button, stop button, temporary loss of power indicator, manual reset circuit breakers, temperature control and monitor panel.

B. Monitor Panel: Back lighted with no visible indicator lights until operating function is activated; indicators include cooling, loss of air flow, change filters, high temperature, low temperature, high head pressure, and low suction pressure.

C. Location: Through hinged door in front of unit; isolated from conditioned air stream to allow service while system is operating.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that flooring system is ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that proper power supply is available and of the correct characteristics.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Coordinate installation of computer room air conditioning units with computer room raised floor installer.

C. Provide adequate drainage connections for condensate.

3.03 FIELD QUALITY CONTROL

A. Provide the services of the manufacturer's field representative to start and adjust systems and equipment and instruct operating personnel.

3.04 SYSTEM STARTUP

A. Prepare and start systems. Set initial temperature and humidity set points.

END OF SECTION

SECTION 23 8200
CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Convectors.

1.02 RELATED REQUIREMENTS

A. Section 23 0719 - HVAC Piping Insulation.

B. Section 23 0913 - Instrumentation and Control Devices for HVAC.

C. Section 23 0993 - Sequence of Operations for HVAC Controls.

D. Section 23 2113 - Hydronic Piping.

E. Section 23 2114 - Hydronic Specialties.

1.03 SUBMITTALS

A. Product Data: Provide typical catalog of information including arrangements.

B. Shop Drawings:
   1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
   2. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.

C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

D. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.04 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide 5 year manufacturer's warranty.

PART 2 PRODUCTS

2.01 HYDRONIC CONVECTORS

A. Manufacturers:
   1. Modine Manufacturing Company
   2. Sterling Hydronics, a Mestek Company
   3. Vulcan Radiator, a Mestek Company

B. Perform factory run test under normal operating conditions, water, and steam flow rates.

C. Heating Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and cast iron headers, steel side plates and supports, factory air pressure tested at 100 psi under water, with means of adjusting pitch of element.

D. Cabinet: 16 gauge, 0.0598 inch sheet steel front and top, 18 gauge, 0.0478 inch sheet steel back and ends; exposed corners rounded; easily secured removable front panels, adequately braced and reinforced for stiffness.

E. Finish: Factory applied baked primer coat.

F. Damper: Where not thermostatically controlled, provide knob-operated internal damper at enclosure air outlet.

G. Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 6 by 7 inch minimum size, integral with cabinet.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are suitable for installation.

B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

B. Install equipment exposed to finished areas after walls and ceilings are finished and painted.

C. Do not damage equipment or finishes.

D. Convectors:
   1. Install where indicated.
   2. Coordinate to ensure correct recess size for recessed convectors.

E. Units with Hydronic Coils:
   1. Provide with shut-off valve on supply piping and tamper-proof, balancing valve with memory stop on return piping.
   2. If not easily accessible, extend air vent to exterior surface of cabinet for ease of servicing.

3.03 CLEANING

A. After construction and painting is completed, clean exposed surfaces of units.

B. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.

3.04 PROTECTION

A. Provide finished cabinet units with protective covers during the balance of construction.

END OF SECTION

SECTION 26 0500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Electrical equipment coordination and installation.

B. Sleeves for raceways and cables.

C. Sleeve seals.

D. Grout.

1.03 RELATED REQUIREMENTS

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

1.04 SUMMARY

A. Common electrical installation requirements.

B. Coordinate with all other trades for all site and perimeter work included within the scope of work. All work to be performed below grade shall be coordinated with all other trades performing work below grade. Provide a planned excavation submittal showing all coordinated systems to be installed below grade, and the associated elevations, prior to commencing any installation of work required in order to complete the scope of work.

1.05 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.06 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.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

D. Coordinate sleeve selection and application with selection and application of Firestopping.

PART 2 PRODUCTS

2.01 SLEEVES FOR RACEWAYS AND CABLES

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

B. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.02 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.
e. Or equal.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Plastic. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.03 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 EXECUTION

3.01 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.

3.02 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

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

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.03 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.04 FIRESTOPPING

A. Apply Firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly.

END OF SECTION

SECTION 26 0500.13
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SCOPE OF WORK

A. All electrical site work in Division 26 shall meet requirements of this section. In addition, this specification is subject to applicable sections of other Divisions of this Work, where equipment and instruments are specified and such equipment and instruments have electrical connections.

B. This work includes all labor, materials, equipment and services for a complete electrical system. Work includes, but is not limited to the following:

1. Electrical equipment and grounding systems.

2. Furnish and install electrical devices as required by National Electrical Code.

3. Furnish and install new circuit breakers, raceways, conductors, boxes/enclosures, and grounding equipment.

4. Make interconnections to equipment provided by others including new Grinder Control Panel, and new Wet Well Control Panel. Provide raceways and conductors to interface with existing devices as shown on the drawings.

5. Furnish and install electrical connections complete to all equipment whether indicated on the plans or not to accomplish a fully functional electrical system as described herein.

6. Provide labeling and marking for all new raceways and equipment.

7. Test all electrical systems to the satisfaction of the Engineer.

C. Under this section provide electric services for and connections to all fixtures, appliances and items of equipment requiring same and shown on any Contract Drawings, and specified under this Division.

D. The Contractor performing electrical work of this Contract shall be licensed to perform work in Fayette County, PA. The Contractor shall be responsible for all fees, permits, licenses, and inspections required to accomplish the work.

1.03 LOCAL CONDITIONS

A. Examine the premises and observe the conditions under which work will be done and all other circumstances which will affect the work before submitting bid. The submittal of a bid will indicate that the Contractor has full knowledge of the challenges involved in the performance of the work.

B. Prior to installation of materials and equipment, discrepancies between plans and actual field conditions or between plans and specifications shall be brought to the attention of the Engineer for clarification.

C. The Contractor shall coordinate with all other trades for proper interface and installation of all electrical items indicated or specified. Any changes in the work shall be the responsibility of the Contractor.

1.04 APPLICABLE CODES AND STANDARDS

A. The installation shall comply with all applicable codes and standards. The construction of the systems indicated and called for in these specifications shall be performed in accordance with standard practices, except as otherwise indicated or specified. The Contractor shall be responsible for obtaining the necessary information to comply with these requirements. Any modification of the drawings or specifications that may be necessary to meet these requirements must be approved by the Engineer or authorized representative before they are made.

B. The Contractor shall give all notices and comply with all laws, ordinances, codes, rules and regulations bearing on the conduct of work as drawn, and specified. If the Contractor observes that the drawings or specifications are at variance therewith, he shall promptly notify the Engineer in writing of any necessary changes in the work. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, codes, rules and regulations, and without such notice to the Engineer, he shall bear all costs to correct the work.

C. Unless stated otherwise in the GENERAL CONDITIONS, the currently adopted codes by the enforcing authorities shall govern. The requirements of the following organizations shall be considered minimum:

1. National Electric Code/ NFPA Codes

2. BOCA Building Code

3. OSHA

4. Local Municipal and County Codes

5. National Electric Safety Code / IEEE

1.05 SUBMITTALS

A. All submittals shall include sufficient data to make a thorough evaluation of features, construction and performance. Submittals shall be bound in booklet form with a cover sheet indicating each item and respective manufacturer's catalog number and shall indicate if the item is as specified or a substitute. Submission of shop drawings in electronic format is encouraged.

B. Materials, equipment and fixtures shall completely satisfy specification requirements and be suitable for their intended use. Items of equipment submitted shall include all accessories and options recommended by the manufacturer for satisfactory, reliable and safe operation in its designated location.

C. Where model number or name of one manufacturer is followed in specifications by one or more other manufacturer's names, design has been based on first product named and shall be considered

to be the specified product or manufacturer, named alternates may require minor deviations. The Contractor shall indicate deviations in submittals/shop drawings.

D. Provide equipment and material specified or named alternates. Products submitted shall be equal in quality to products of the specified manufacturer and shall include the standard features of the specified product and also optional features or necessary changes specified herein. Submittal of alternates shall include all changes in building systems, piping, wiring, supports or accessories required for satisfactory and intended operation. The Engineer shall make all determinations regarding equivalence.

E. Manufacturer's model and catalog numbers included in the specifications may not include all specified or required features and may not insure compatibility with supporting systems or intended application. Contractor shall insure that material and equipment delivered to job site is suitable for the intended application and indicated connections. Review of shop drawings shall not include review and verification of submitted catalog numbers or quantities required.

F. Review of Contractor's submitted shop drawings and noted comments on Contractor's submitted shop drawings does not constitute a change order or a waiver of Contract requirements. In the event of conflict between submittals or shop drawings and Contract Documents, the latter shall govern. If waiver of particular requirement is requested by Contractor, a formal written request shall be made to the Engineer for presentation to the Owner.

G. When directed, Contractor shall provide samples of material or equipment.

H. Equipment shall be shipped or fabricated in sections of suitable size for entering buildings and all necessary arrangements for their installation shall be made by Contractor.

I. Shop drawings and submittals shall bear the Contractor's review and approval stamp prior to submission to the Engineer.

J. Submit copies of shop drawings for all electrical equipment custom-made for this Contract. If necessary, drawings shall be revised as directed and resubmitted.

K. Manufacturer's drawings, sketches, and instructions shall supplement but not supersede Contract Drawings and specifications.

L. Submittals shall show:

1. Physical size and arrangement of equipment.

2. Wiring diagrams for all equipment showing all circuit devices, conductor sizes, color coding, type, etc.

3. Elementary control diagrams in straight line form for motor control equipment showing all control devices connected to the system.

4. Specifications for all components.

1.06 MATERIALS AND ACCESSORIES

A. Materials shall be new and listed by the Underwriters Laboratories, Inc., or locally approved national testing agency as conforming to standards in every case where such a standard has been established for the particular materials in question.

B. Equipment shall be packaged in their original containers and be limited to products regularly produced and recommended for service ratings in accordance with manufacturer's catalogs, engineering data or other comprehensive literature made available to the public, and in effect at the time of contract award and shall be turned over to the Owner free of all defects.

C. All equipment or materials for any one system shall be furnished by the same manufacturer. Such items as lamps, conduit fittings, wire, electrical switchgear, wiring devices, etc., shall be the same throughout the project.

D. Materials installed on exterior of buildings shall be weather tight and of such design as intended for this purpose.

E. Equipment shall be installed in strict accordance with manufacturer's instructions for type, capacity and suitability of each piece of equipment used. Use weatherproof equipment where required. Install equipment in accordance with manufacturer's recommendations and meet conditions for manufacturer's standard warranty.

F. Contractor shall effectively protect his work, materials, or equipment which are liable to damage during construction period. Openings into any part of conduit system as well as associated fixtures, equipment, both before and after being set in place must be securely covered or otherwise protected to prevent obstruction of conduit or damage due to carelessness, dropped tools or materials, grit, dirt, or any foreign matter. Contractor is responsible for all damage so done until his work is installed and accepted. Conduit ends shall be covered with capped bushings.

G. Provide all accessories, equipment and connections required for complete installation, ready for continuous use by Owner.

H. All material and equipment shall conform to capacity, efficiency, design and material specified and shall meet dimension and space requirements. Sizes of materials and equipment indicated or specified are minimum requirements. The Contractor may use larger sizes to expedite the work provided that such change meets space requirements and does not result in additional installation, maintenance or operating cost to the Owner. Equipment or materials of the same type or classification, used for the same purpose shall be the products of the same manufacturer.

1.07 INSPECTION AND REGULATIONS

A. Contractor shall arrange for all inspections specified herein or required by all agencies having jurisdiction and furnish required certificates of inspection to Owner, including electrical certificate from State licensing agency.

B. Do not allow or cause any work to be covered up or enclosed until it has been inspected, tested and approved by the authorities having jurisdiction over the work and the Engineer. Should any Work be enclosed or covered before such an inspection and test, Contractor shall, at his own expense, uncover the work and after it has been inspected, tested and approved make all repairs with such material as may be necessary to restore all of his work and that of any other Contractor to its original condition.

C. Work shall meet requirements of Owner, Township or Borough, National Electrical Code, local regulations, and rules of the electric service provider (Utility Company). Equipment and materials shall bear label of approval of National Board of Fire Underwriters and be UL listed for their particular application.

D. Work shall meet requirements of the Owner's insurer.

1.08 ELECTRICAL ABBREVIATIONS, REFERENCES AND DEFINITIONS

A. Abbreviations and symbols herein and on Drawings are in accordance with ANSI Standard Y1.

B. References to technical societies, trade organizations and governmental agencies in the Electrical Division are in accordance with the following:

1. ANSI – American National Standards Institute

2. ASTM – American Society for Testing Materials

3. IEEE – Institute of Electrical and Electronics Engineers, Inc.

4. NEC – National Electric Code

5. NEMA – National Electrical Manufacturers Association

6. NFPA – National Fire Protection Association

7. OSHA – Occupational Safety and Health Administration

8. UL – Underwriter's Laboratories, Inc.

C. The following definitions of terms and expressions are applicable to the Electrical Division.

1. "Provide" shall mean "furnish and install."

2. "Herein" shall mean "contents of a particular Division" where this term appears.

3. "Indicated" shall mean "indicated on Contract Drawings."

4. "equal" shall mean "approved equivalent."

5. "Contractor" shall mean "Contractor or subcontractor for work described."

1.09 SYSTEM OPERATION INSTRUCTIONS

A. Verbal Instruction

1. After all tests and adjustments, Contractor shall instruct attendant or Owner's representative in all details of operation of the distribution and branch circuit systems and all other systems installed under Electrical portion of this Contract.

2. Provide necessary assistance to operate the systems until Engineer is satisfied that the systems have been installed in accordance with the Drawings and Specifications and are functioning properly.

3. Provide services and equipment manufacturer's engineer to instruct representative of Owner in operation and maintenance of electrical equipment.

B. Written Instruction

1. Provide three (3) copies of printed instructions and diagrams covering operation and maintenance of each item of equipment.

2. Furnished Instructions in bound covers and post at locations designated by Construction Project Manager or authorized representative.

3. Provide one set in electronic format.

1.10 TESTS

A. Give timely notice of intention to test or cover up work to permit observation. Contractor shall test all wiring for continuity and grounds before connecting any equipment or outlets. Contractor shall test entire system in accordance with current procedures stated in Acceptance Testing Specifications published by the National Electric Testing Association, Inc. All equipment necessary to conduct such test shall be furnished at the Contractor's expense.

B. Arrange and pay for all tests. Notify Engineer three (3) working days before tests are made. Conduct tests in presence of Construction Project Manager or authorized representative. Repeat tests after defects are corrected.

C. Prior to tests, prove (continuity of) feeders and branch circuits continuous from main distribution panel to outlets, fixtures, and equipment. See other sections of this specification for other required tests.

1. Demonstrate system is free from short circuits and properly grounded.

2. Check all motors for correct rotation.

3. Test load balance as specified herein.

1.11 FIELD MEASUREMENTS

A. Visit the site before submitting bid and check location of existing utilities, conditions, verify dimensions and locations shown on the plans and over all costs and work herein described or shown.

B. Take measurements necessary for this work and be responsible for their accuracy. Provide all necessary pull boxes and junction boxes as required to accomplish distribution.

1.12 STRUCTURAL DIFFICULTIES

A. Should structural difficulties prevent performing work, necessary deviations, as determined by Engineer, shall be performed.

1.13 DRAWINGS AND SPECIFICATIONS

A. Drawings shall be considered schematic in nature and shall represent a completed product. Contractor is responsible for installation of equipment and methods of achieving a satisfactory and intended installation. Locations of devices are intended to show a general arrangement and intended function. Door swings and architectural features shall be checked for final condition. Coordinate with all Contract Documents and with other trades.

B. Where a conflict exists between Drawings and Specifications, the Engineer shall be contacted to determine the intent. In all circumstances, the final Contract Document interpretation shall provide compliance with all codes.

C. Wiring devices shall be located uniformly with respect to building structure and other work. Locations shall be coordinated. Should there be any interference between electrical wiring and other trades, Contractor shall notify the Engineer so that proper location may be determined.

D. Maintain a complete set of Contract Documents on the project site. As work is installed, carefully draw on prints, in red colored pencil, correct locations of work installed with dimensions from permanent walls, wiring diagrams and details corrected. On completion of project, deliver as-built prints to Owner in good condition.

1.14 CUTTING AND PATCHING

A. Contractor shall install all hangers, supports and sleeves in floors, walls, partitions, ceilings, and roof slabs as construction progresses to permit their work to be built into place and to eliminate unnecessary cutting of construction work.

B. All cutting of concrete or other material for the passage of conduit through floors, walls, partitions and ceilings shall be done by the Contractor where necessary to install his work. Contractor will close all such openings around conduit with material equivalent to that removed. All exposed surfaces shall be left in suitable condition for refinishing without further work.

C. Where conduit passes through fire rated walls and floors, seal opening with fire resistant elastic adhesive compound.

D. No structural member shall be altered or cut without the special permission of the Engineer.

1.15 EQUIPMENT SUPPORTS AND STANDS

A. Design and construct supporting structures of strength to safely withstand stresses to which subjected and to distribute the load properly. Provide supports constructed of American Steel "Kindorf" or equivalent.

B. Respective Contractor shall provide required supports for equipment provided by them and submit detailed shop drawings for approval before construction.

1.16 PERMITS

A. All permits, licenses or incidental fees, or permits necessary for this work shall be secured and paid for by the Contractor unless otherwise noted.

1.17 GUARANTEE

A. Unless otherwise specified, guarantee unconditionally for a guarantee period as set forth in General Conditions all materials, workmanship and installation. During this period, adjust, repair or replace, at no cost to the Owner, any item of equipment or workmanship found to be defective.

B. Contractor shall be responsible for and pay for damages caused by or resulting from defects in workmanship.

PART 2 – MATERIALS

Not Used

PART 3 – EXECUTION

Not Used

END OF SECTION

SECTION 26 0502
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SUMMARY

A. This Section includes general administrative, procedural, and installation requirements for electrical installations.

1.03 DEFINITIONS

A. Definitions pertaining to Division 26:
   1. Provide: Furnish and install.
   2. Furnish: Furnish only (installation by others).
   3. Install: Mount, make all connections and have in operation.
   4. Indicated: On Contract Drawings or stated herein.
   5. Concealed: Hidden from sight at completion of work.
   6. Homerun: Branch circuit conductors and conduit between over current protection and load.
   7. Circuit: Electrical conductors (power, control, instrumentation, etc.) and associated conduit.
   8. Trade: General Contractor, HVAC, plumbing, etc.
   9. Or Approved Equal: Equal in the judgment of the Engineer.
   10. Utility: Local provider of electrical power, telephone, or cable television.

1.04 QUALITY ASSURANCE

A. Qualifications of Installers:
   1. For the actual fabrication, installation and testing of the Work of this Division, only use thoroughly trained and experienced personnel who are completely familiar with the codes and requirements for this Work and with the installation recommendations of the manufacturers of the specified items.

B. Workmanship:
   1. Complete electrical installation shall be made in a neat and workmanlike manner and to the full satisfaction and approval of the Owner and Engineer.
   2. Work not meeting Owner's or Engineer's standard for adequate workmanship shall be removed and replaced at once, at no additional Contract cost to the Owner.
   3. Remove and replace all work rejected by Owner or Engineer as defective, non-operational or not in conformance with intent of this Contract.

1.05 SUBMITTALS

A. Submit shop drawings and pertinent product information as per Division 1 and as specified herein.

B. Substitutions:
   1. Materials of greater or equal quality, function, and performance may be proposed for substitution by submitting product information as described above two weeks minimum prior to the bid date. Submittal shall clearly indicate that it is a substitution, and clearly list all differences from the specified.

C. Samples: Where indicated or requested, provide the Engineer with a sample of the intended product.

D. Submittals shall be clear and concise. The submittals shall clearly indicate the product name, applicable Specification Section, proposed location, equipment supplier with telephone number and all features and ratings. The intended product shall be differentiated from others with a model number or highlighting. Product differences from that specified shall be noted and brought to the attention of the Engineer. Such differences shall be listed at the beginning of the submittal.

E. Submittals for equipment that is to be installed within “Electrical Rooms”, or rooms that have electrical equipment within them, shall include floor plans with scaled drawings showing equipment layout within room.

F. If equipment or materials are installed before proper approvals have been obtained, each Contractor shall be liable for their removal and replacement including work of other trades affected by such work, at no additional cost to the Owner, if such items do not meet intent of the Drawings and Specifications.

G. The Engineer reserves the right to reject any submittal that contains equipment from various manufacturers if suitable materials can be secured from fewer manufacturers.

1.06 TRAINING

A. Provide system training for all systems included herein. Training shall be complete and include all individual system functions, features, operation and maintenance. The training shall be scheduled at the Owner’s convenience and be for the Owner and its designated representatives. A minimum of two copies of materials used (videos, pamphlets, manuals, presentations, etc.) shall be provided to the Owner. The training shall be thorough enough for the attendees to understand all that is presented and additional sessions shall be scheduled as needed for a full understanding.

1.07 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 1 detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
   1. Indicate the proposed locations of major raceway systems, equipment, and materials. Include the following:
      a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
      b. Exterior wall and foundation penetrations.
      c. Fire-rated wall and floor penetrations.
      d. Equipment connections and support details.
      e. Sizes and location of required concrete pads and bases.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, luminaries, communications systems components, sprinklers, and other ceiling-mounted devices.

E. Coordinate with other trades to determine areas of conflict. Inform the Engineer of such areas of conflict and the proposed resolution.

1.08 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, indicate installed conditions for:
   1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
   2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
   3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

B. Engage the services of a Land Surveyor or Professional Engineer registered in the state in which the project is located as specified in Division 1 to record the locations and invert elevations of underground installations.

C. During progress of the Work, maintain an accurate record of the installation of the electrical system, locating each circuit precisely by dimension.

D. Record drawings shall be acceptable to the Owner and Engineer. Any changes to the Record Drawings, as directed by the Owner or Engineer, shall be made by the Contractor.

1.09 OPERATIONS AND MAINTENANCE MANUALS

A. Prepare operations and maintenance manuals in accordance with Division 1. In addition to the requirements specified in Division 1, include the following information for equipment items:
   1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
   2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
   3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
   4. Servicing instructions and lubrication charts and schedules.
   5. Names and telephone numbers of local service and parts supply organization.

1.10 TEST RESULTS

A. Provide test results in accordance with Division 1.

PART 2 PRODUCTS

2.01 PRODUCT STORAGE AND HANDLING

A. Protection: Use all means necessary to protect electrical system materials before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

C. The Contractor shall be responsible for the work of other trades that may be damaged or disturbed in the course of his work and shall restore the damaged work to the condition existing prior to damage without additional cost to the Owner.

2.02 EQUIPMENT AND MATERIALS

A. All equipment and materials shall be of the capacity and type shown on the Drawings and specified herein and shall be as manufactured by one of the manufacturers designated or shall be an equal approved in advance by the Engineer.

B. All other materials, not specifically described but required for a complete and operable electrical installation, shall be new, first quality of their respective kinds, and as selected by the Contractor subject to the approval of the Engineer.

C. Install all equipment and materials in complete accordance with the manufacturer's recommendations and all pertinent codes and regulations.

D. Materials and equipment shall be listed by Underwriters Laboratories unless it can be demonstrated that no UL standards exist for specific items or class of equipment.

E. Equipment and component parts thereof shall bear manufacturer's nameplate, giving manufacturer's name, size, type and model number or serial number, electrical characteristic to facilitate maintenance and replacements. Nameplates of distributors or contractors are not acceptable.

F. Equipment shall be suitable for the intended location and use.

G. Equipment terminations/lugs shall be sized for the required temperature rating and indicated wire size as a minimum.

PART 3 EXECUTION

3.01 SURFACE CONDITIONS

A. Inspection:
   1. Prior to all work of this Division, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
   2. Verify that the electrical installation may be made in complete accordance with all pertinent codes and regulations and the original design.

B. Discrepancies:
   1. In the event of discrepancy, immediately notify the Engineer.
   2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 PREPARATION

A. Coordination:
   1. Coordinate the installation of electrical items with the schedules for work of other trades and building components to prevent unnecessary delays in the total Work. Coordinate specific equipment connections and requirements with the trade providing the equipment.
   2. Coordinate with utility company and make all installations for their services in accordance with all utility company requirements. The Contractor shall arrange for and assume all utility costs associated with this contract.
   3. Any changes due to improper coordination shall be done at the Contractor's expense.
   4. Where luminaires and other electrical items are shown in conflict with locations of structural members and mechanical or other equipment, furnish and install all required supports and wiring to clear the encroachment.
   5. Any Work installed contrary to or without approval of the Engineer shall be subject to change as directed by the Engineer, and no extra compensation will be allowed the Contractor for making these changes.

B. Accuracy of Data:
   1. The Drawings are diagrammatic and functional only, and are not intended to show exact layouts, number of fittings, or other installation details. The Contractor shall furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. The Contractor shall install additional circuits wherever needed to conform to the specific requirements of the equipment.

2. The locations of equipment, materials, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be verified during construction so that they shall coordinate with all other work, equipment and trades. The Contractor shall obtain in the field all information relevant to the placing of electrical work and, in case of any interference with other work, shall proceed as directed by the Engineer and shall furnish all labor and materials necessary to complete the Work in an approved manner.
3. The ratings of motors and other electrically operated devices, together with the size shown for their branch circuit conductors and conduits, are approximate only, and are indicative of the probable power requirements insofar as they can be determined in advance of the purchase of equipment. Equipment sizes may vary from sizes indicated on the drawings and must be verified with actual equipment to be furnished and coordinated with all other equipment and material sizes.

3.03 DIMENSIONS, ELEVATIONS, AND LAYOUTS

A. It shall be the responsibility of the Contractor to verify dimensions and elevations shown or scaled on Drawings by actual field measurements after building construction has progressed to the point where such measurements may be taken.

B. Advise Owner & Architect in writing regarding those critical dimensions that must be held by other Trades as they perform their work.

C. Assume full responsibility for accuracy of all work under this Division and make corrections as required.

D. It shall be this Division's responsibility to coordinate with all other Trades and separate equipment contracts regarding mechanical equipment layouts, space requirements, mounting details, "roughing-in" dimensions, and for items substituted for those specified herein to avoid conflict.

E. Arrange for disassembling large pieces of equipment for entry into buildings as necessary to pass through available openings. Disassembly shall not void UL Listing or manufacturer’s warranty. If such disassembly voids UL listing, the Contractor is responsible for obtaining and paying for UL re-certification of equipment.

F. Layouts of feeders and wiring shown on Drawings are diagrammatic, and shall be constructed as such, intended to show scope of work and general arrangement, unless otherwise noted.

G. Equipment locations shall be as indicated unless prohibited by equipment dimensions, codes or the manufacturer's recommendations. In such an event, contact the Engineer.

3.04 EQUIPMENT CLEANING

A. Thoroughly inspect all equipment and any items dented, scratched or otherwise damaged in any manner shall be replaced or repaired and painted to match original finish:
   1. All items so repaired and refinished shall be brought to the attention of the Engineer for inspection and approval.

B. Upon completion of all installation, lamping, and testing, thoroughly inspect all exposed portions of the electrical installation and completely remove all exposed labels, soil, markings and foreign material.

3.05 EXISTING SERVICES

A. Active: When encountered in work, protect, brace, support existing active drains, gas, electric, water, other services where required for proper execution of work. If existing active services are encountered that require relocation, make request in writing for determination. Do not prevent or disturb operation of active services that are to remain. Repair existing service disturbed during work under this contract at no cost to the Owner. Record any existing services encountered on "as-built" drawings.

B. Inactive Services: When encountered in work, remove cap or plug inactive services. Notify Owner; protect or remove these services as directed. Record on "as-built" drawings.

C. Interruption of Services: Where work makes temporary shutdowns of services unavoidable, shutdown at night or at such terms as approved by Owner, which will cause least interference with established operating routine. Arrange to work continuously, including overtime, if required, to assure that services will be shutdown only during time actually required to make necessary connections to existing work.

3.06 TEMPORARY SERVICES

A. Coordinate temporary requirements with those indicated in Division 1.

B. Electric: Provide temporary electric service as needed for all trades included with this project throughout the construction period. If there is no existing service or the existing service is not sufficient for the added construction load or if no service exists, temporary electrical service shall be provided, including securing and paying for all services rendered by the utility company which is required in order to provide temporary service.
   1. Temporary electrical service shall be coordinated with the utility and be sized for the maximum construction load.
   2. All power requirements of individual trades shall be provided except that temporary power shall not be used for heating or welding applications.
   3. All wiring shall be in accordance with the NEC.
   4. All receptacles shall be ground fault protected.

C. Lighting: Provide temporary lighting for construction needs throughout the construction period, including re-lamping throughout the duration of construction. Areas to be illuminated shall include but not be limited to:
   1. Construction areas: Uniform 20 foot candles minimum.
   2. Security area: Uniform 1 foot candle minimum.
   3. Temporary offices, storage, shop and other construction buildings: Light levels as required.

D. Telephone: Each prime contractor shall be responsible to provide temporary telephone service for their own use.

3.07 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
   1. Coordinate electrical systems, equipment, and materials installation with other building components.
   2. Verify all dimensions by field measurements.
   3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
   4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
   5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
   6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
   7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
11. Install access panels or doors where splices, junctions, pull points, etc. are concealed behind finished surfaces.
12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

B. Coordinate with the Owner, architectural drawings, etc for the locations of the expansion joints, fire walls and smoke walls/partitions. Suitable expansion/deflection fittings shall be provided at all expansion joints and at recommended lengths of raceway. Fire/gas stopping shall be provided at all walls/floor/partitions penetrations. Fire stopping rating shall match or exceed the walls/floor/partitions rating.

3.08 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1. In addition to the requirements specified in Division 1, the following requirements apply:
   1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
      a. Uncover Work to provide for installation of ill-timed Work.
      b. Remove and replace defective Work.
      c. Remove and replace Work not conforming to requirements of the Contract Documents.
      d. Remove samples of installed Work as specified for testing.
      e. Install equipment and materials in existing structures.
   2. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer's observation of concealed Work.
   3. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
   4. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
   5. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
   6. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

3.09 GUARANTEE

A. Furnish guarantee covering all work in accordance with general requirements of the contract for minimum period of one year. This personal guarantee shall exist for a period of one (1) year from the date of final acceptance of the work and shall apply to defects in materials and to defective workmanship of any kind.

B. For factory-assembled equipment and devices on which the manufacturers furnish standard published guarantees as regular trade practice, obtain such guarantees and replace any such equipment that proves defective during the life of these guarantees.

C. Guarantee all work for which materials are furnished, fabricated or field erected by the Contractor, all factory-assembled equipment for which no specific manufacturer's guarantee is

furnished, and all work in connection with installing manufacturer's guaranteed equipment.

D. In the event of failure of any work, equipment or device during the life of the guarantee, repair or replace the equipment or defective work. Remove, replace or restore, at no cost to the Owner, any part of the structure or building which may be damaged either as the direct result of the defective work or in the course of the contractor's making replacement of the defective work or materials. Work shall be done at a time and in a manner as to cause no undue inconvenience to the Owner. Provide new materials, equipment, apparatus and labor to replace that determined by Engineer to be defective or faulty.

E. This guarantee also applies to services including instructions, adjusting, testing, etc.

3.10 PROJECT OBSERVATION

A. Contractor shall accompany the Engineer for all project observation/walk through, remove equipment covers as directed and provide all requested equipment (meters, samples, ladder, etc.).

3.11 VIBRATION ISOLATION

A. Vibration isolators shall prevent, as far as practicable, transmission of vibration, noise or hum to any part of building.

B. Design isolators to suit vibration frequency to be absorbed; provide isolator units of area, distribution to obtain proper resiliency under machinery load, impact.

C. Wiring and other electrical connections to equipment mounted on vibration isolators shall utilize flexible metal conduit in order to avoid restraining equipment and short circuiting vibration isolator.

END OF SECTION

SECTION 26 0519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Single conductor building wire.

B. Wiring connectors.

C. Electrical tape.

D. Wire pulling lubricant.

E. Cable ties.

1.03 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 2100 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conductors.

1.04 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire.

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation.

E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.

F. NECA 1 - Standard for Good Workmanship in Electrical Construction.

G. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

I. NFPA 70 - National Electrical Code.

J. UL 44 - Thermoset-Insulated Wires and Cables.

K. UL 83 - Thermoplastic-Insulated Wires and Cables.

L. UL 486A-486B - Wire Connectors.

M. UL 486C - Splicing Wire Connectors.

N. UL 486D - Sealed Wire Connector Systems.

O. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

B. Field Quality Control Test Reports.

C. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.09 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductors for Grounding and Bonding: Also comply with Section 26 0526.

H. Conductor Material:
   1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.

2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
3. Tinned Copper Conductors: Comply with ASTM B33.

I. Minimum Conductor Size:
1. Branch Circuits: 12 AWG.
a. Exceptions:
1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
2. Control Circuits: 14 AWG.

J. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

K. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
3. Color Code:
a. 480Y/277 V, 3 Phase, 4 Wire System:
1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.
4) Neutral/Grounded: Gray.
b. 208Y/120 V, 3 Phase, 4 Wire System:
1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.
4) Neutral/Grounded: White.
c. 240/120 V, 1 Phase, 3 Wire System:
1) Phase A: Black.
2) Phase B: Red.
3) Neutral/Grounded: White.
d. Equipment Ground, All Systems: Green.
e. Travelers for 3-Way and 4-Way Switching: Pink.
f. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:
1. Feeders and Branch Circuits:
a. Size 10 AWG and Smaller: Solid.
b. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation:
1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
a. Size 4 AWG and Larger: Type XHHW-2.
b. Installed Underground: Type XHHW-2.

2.04 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 26 0526.

C. Wiring Connectors for Splices and Taps:
   1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
   2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.

D. Wiring Connectors for Terminations:
   1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
   2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
   3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
   4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
   5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.

E. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

F. Mechanical Connectors: Provide bolted type or set-screw type.

G. Compression Connectors: Provide circumferential type or hex type crimp configuration.

2.05 ACCESSORIES

A. Electrical Tape:
   1. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.

B. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

C. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated without specific routing, determine exact routing required.
   3. Arrange circuiting to minimize splices.
   4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
   5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
   6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
      a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
      b. Increase size of conductors as required to account for ampacity derating.
      c. Size raceways, boxes, etc. to accommodate conductors.
   8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Installation in Raceway:
   1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
   2. Pull all conductors and cables together into raceway at same time.
   3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
   4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

G. Install conductors with a minimum of 12 inches of slack at each outlet.

H. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

I. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

J. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

K. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

L. Insulate ends of spare conductors using vinyl insulating electrical tape.

M. Identify conductors and cables in accordance with Section 26 0553.

N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.

C. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26 0519.13
LOW VOLTAGE ELECTRICAL CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SUMMARY

A. This Section includes the following for site electrical work:

1. Building wires and cables rated 600 V and less.

2. Connectors, splices, and terminations rated 600 V and less.

1.03 SUBMITTALS

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

1.04 QUALITY ASSURANCE

A. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES

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

1. Alcan Products Corporation; Alcan Cable Division.

2. Alpha Wire Company

3. American Insulated Wire Corp.; a Leviton Company.

4. General Cable Corporation.

5. Southwire Company.

B. Single Conductors

1. Stranded copper single conductor 600 volt insulated.

2. Minimum size for branch circuits shall be #12AWG.

3. Discrete control conductors shall be #14 AWG

C. Multi-conductor Power Cables

1. 600 volt multi-conductor power cables shall be composed of single conductors, Type THHN/THWN, XHHW-2 or as otherwise noted. The single conductors are to be cables which are bound by a flame-retardant, moisture and sunlight resistant jacket of PVC or other jacket material as noted.

2. 600 volt multi-conductor cables shall satisfy the requirements of NEC and UL for Type TC power and control tray cables.

3. VFD Cables:
   a. Comply with UL 1277, UL 1685 and NFPA 70 for type TC-ER Cable.
   b. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full size ground wire or dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight and oil- resistant outer PVC jacket.

D. Copper Conductors: Comply with NEMA WC 70.

E. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN, XHHW, UF, USE, and SO.

1. General:
   a. Use THHN for all indoor, dry locations.
   b. Use XHHW-2 for underground conductors.

2. All spliced conductors shall include the same insulation.

F. Multi-conductor Instrumentation and Signal Cables

1. Multi-conductor analog signal cables shall be #18 AWG minimum and shall include 300 volt insulation minimum. The cables shall include 600 volt insulation if installed in raceways with other conductors rated at 600 volts.

2. Analog signal cables shall be twisted and shall include an overall (foil) shield in constant contact with a copper drain wire.

3. Other signal cables (pairs or triads) shall be individually shielded. The cable shall also have an overall shield.

4. Conductors shall be composed of soft annealed copper with PVC insulation and a nylon overcoat with a flame retardant, moisture and sunlight resistant jacket.

2.02 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.

2. Hubbell Power Systems, Inc.

3. O-Z/Gedney; EGS Electrical Group LLC.

4. 3M; Electrical Products Division.

5. Tyco Electronics Corp.

6. Ideal Industries Inc.

B. Conductors #8 AWG and larger shall be terminated and spliced with Burndy or T & B Mechanical pressure connectors.

C. Conductors Smaller than #8 AWG shall be terminated with mechanical (screw or crimp) type connectors. Wire nuts are not acceptable.

D. Insulating tape shall be vinyl plastic insulating tape, 7 mil thick, Scotch 33+ or equal. Apply to all joints and splices. Tape shall be color coded to indicate phase.

E. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Stranded for No. 12 AWG and larger.

B. Branch Circuits: Copper. stranded for all No. 12 AWG and larger.

3.02 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. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW -2, single conductors in raceway.

D. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

F. Load side of VFDs shall be XHHW-2 (or VFD cables if specified or shown on drawings).

G. Cord Drops and Portable Appliance Connections: Type SO, SJ hard service cord.

3.03 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."

3.04 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. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification for circuits larger than 100 amperes. 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

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

F. Ground access wells.

1.03 RELATED REQUIREMENTS

A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

B. Section 26 0536 - Cable Trays for Electrical Systems: Additional grounding and bonding requirements for cable tray systems.

C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 4113 - Lightning Protection for Structures.

E. Section 26 5600 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.04 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

E. NFPA 70 - National Electrical Code.

F. NFPA 99 - Health Care Facilities Code.

G. NFPA 780 - Standard for the Installation of Lightning Protection Systems.

H. UL 467 - Grounding and Bonding Equipment.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify exact locations of underground metal water service pipe entrances to building.
   2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
   3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

B. Field quality control test reports.

C. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

D. Grounding System Resistance:
   1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
   3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

E. Grounding Electrode System:
   1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
      a. Provide continuous grounding electrode conductors without splice or joint.
      b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
   2. Metal Underground Water Pipe(s):
      a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
      b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
      c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
   3. Metal In-Ground Support Structure:
      a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
   4. Concrete-Encased Electrode:

a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.

5. Ground Ring:
   a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 4/0 AWG in direct contact with earth, installed at a depth of not less than 30 inches.
   b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.
   c. Provide connection from ground ring conductor to:
      1) Perimeter columns of metal building frame.
      2) Ground rod electrodes located as indicated.
6. Ground Rod Electrode(s):
   a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
   b. Space electrodes not less than 10 feet from each other and any other ground electrode.
   c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
7. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
8. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
   a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
   b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
   c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

F. Service-Supplied System Grounding:
   1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
   2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

G. Separately Derived System Grounding:
   1. Separately derived systems include, but are not limited to:
      a. Transformers (except autotransformers such as buck-boost transformers).
      b. Generators, when neutral is switched in the transfer switch.
   2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
   3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.

4. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

H. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
    a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
    b. Metal gas piping.
8. Provide bonding for interior metal air ducts.
9. Provide redundant grounding and bonding for patient care areas of health care facilities in accordance with NFPA 70 and NFPA 99.

I. Communications Systems Grounding and Bonding:
1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
    a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
    b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
    c. Ground Bar Size: 1/4 by 4 by 12 inches unless otherwise indicated or required.
    d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

J. Lightning Protection Systems, in Addition to Requirements of Section 26 4113:
1. Do not use grounding electrode dedicated for lightning protection system for component of building grounding electrode system provided under this section.
2. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with NFPA 70 and NFPA 780.

K. Cable Tray Systems: Also comply with Section 26 0536.

L. Pole-Mounted Luminaires: Also comply with Section 26 5600.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
   1. Provide products listed, classified, and labeled as suitable for the purpose intended.
   2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:
   1. Use insulated copper conductors unless otherwise indicated.
      a. Exceptions:
         1) Use bare tinned copper conductors where installed underground in direct contact with earth.
         2) Use bare tinned copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
   2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
   3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

D. Ground Bars:
   1. Description: Copper rectangular ground bars with mounting brackets and insulators.
   2. Size: As indicated.
   3. Holes for Connections: As indicated or as required for connections to be made.

E. Ground Rod Electrodes:
   1. Comply with NEMA GR 1.
   2. Material: Copper-bonded (copper-clad) steel.
   3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.

F. Ground Access Wells:
   1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
   2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
      a. Round Wells: Not less than 8 inches in diameter.
      b. Rectangular Wells: Not less than 12 by 12 inches.
   3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
   4. Cover: Factory-identified by permanent means with word "GROUND".

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as indicated.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
   1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.

D. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
   3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
   4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.13.

C. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

SECTION 26 0526.13
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SCOPE OF WORK

A. This Section includes the requirements for electrical grounding and bonding for site electrical work.

1.03 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. Comply with UL 467 for grounding and bonding materials and equipment.

1.04 SUBMITTALS

A. Shop Drawings

1. Submit catalog cuts and descriptive literature for approval by the Engineer. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

2. Submittals: rods, connectors, and exothermic welding systems, intersystem bonding terminals, inspection wells.

3. As Built Data: Plans showing dimensioned as-built locations of grounding features including but not limited to the following:

   a. Ground Bus location and dimensions
   b. Other grounding connections and arrangements

B. Reference

1. National Electric Code (NEC) article 250.

PART 2 - PRODUCTS

2.01 GROUNDING WIRES

A. Wires shall be UL and NEC approved types, copper, with insulation color identified green, except where otherwise shown on the drawings, or specified.

B. Wire size shall not be less than shown on the drawings and not less than required by the NEC.

C. Bare copper conductors

1. Bonding Conductor: #4 or #6 AWG stranded conductor.

2. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules (1 5/8 inches wide and 1/16 inch thick).

2.02 CONNECTORS

A. Listed and labeled by an agency acceptable to the Authority Having Jurisdiction for applications in which the product is being used.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

2.03 GROUND RODS

A. Copper-clad, 10 feet, 5/8 inch diameter.

2.04 INTERSYSTEM BONDING TERMINALS

A. Compliance.

1. Provide intersystem bonding terminal(s) compliant with 2014 NEC Article 250.94 or other listing included in the latest adopted version of the National Electric Code.

2. Intersystem Bonding Terminal shall be recognized by UL or other authorized and recognized testing agency acceptable to the Engineer.

3. Refer to electrical drawings for requirements.

B. Shall accommodate at least 5 #14 to #4 conductors and 1 #6 to #2 grounding electrode conductor. Shall include a polymeric base and cover which is UV resistant.

C. Provide Erico IBTB or equal.

PART 3 - EXECUTION

3.01 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Connections to Structural Steel: Welded connectors.

3.02 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

3.03 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.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's writer instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of- potential method according to IEEE 81.

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

D. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 Kva and Less: 10 ohms.

2. Power and Lighting Equipment or System with Capacity of 500 to 1000 Kva: 5 ohms.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.03 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 0533.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.

C. Section 26 0536 - Cable Trays for Electrical Systems: Additional support and attachment requirements for cable tray.

D. Section 26 0533.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.

E. Section 26 5100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

F. Section 26 5600 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.04 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

D. MFMA-4 - Metal Framing Standards Publication.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction.

F. NFPA 70 - National Electrical Code.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

B. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

1.07 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.25. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
      c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   1. Comply with MFMA-4.
   2. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
   3. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.

E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.

1. Minimum Size, Unless Otherwise Indicated or Required:
    a. Equipment Supports: 1/2 inch diameter.
    b. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.
    c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
    d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
    e. Outlet Boxes: 1/4 inch diameter.
    f. Luminaires: 1/4 inch diameter.

F. Non-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

G. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Wood: Use wood screws.
9. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    a. Comply with MFMA-4.
    b. Channel Material: Use galvanized steel.
    c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 4 inch high concrete pad constructed in accordance with Section 03 3000.
   5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Conduit Support and Attachment: Also comply with Section 26 0533.13.

I. Cable Tray Support and Attachment: Also comply with Section 26 0536.

J. Box Support and Attachment: Also comply with Section 26 0533.16.

K. Interior Luminaire Support and Attachment: Also comply with Section 26 5100.

L. Exterior Luminaire Support and Attachment: Also comply with Section 26 5600.

M. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

N. Secure fasteners according to manufacturer's recommended torque settings.

O. Remove temporary supports.

P. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 0529.13
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SUMMARY

A. This Section includes the following for site electrical work:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.03 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Provide product data for each type of support and hanger. Include data describing features, accessories and finishes.

1.04 DEFINITIONS

A. ARC: Aluminum Rigid Conduit.

B. EMT: Electrical Metal Tubing.

C. GRC: Galvanized Rigid Steel Conduit.

D. IMC: Intermediate Metal Conduit.

E. RMC: Rigid Metal Conduit.

1.05 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.06 COORDINATION

A. Coordinate the size and location of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.01 SUPPORTS AND HANGERS

A. Conduit shall be supported in accordance with the National Electrical Code.

B. Conduits shall be supported by strut support system of the same material as the conduit (example: aluminum strut for ARC). The supports system shall consist of threaded rod, strut, clamps, straps,

fasteners, etc., matching the support system material.

C. No electrical equipment of any nature shall be fastened directly to masonry surfaces.

D. Where supporting channels are fastened to masonry walls, toggle bolts, expansion shields or through bolts shall be used. Wood or plastic plug masonry anchors shall not be used.

E. Provide "supports" or "hangers" (brackets, rods, angle members, channel, clamps, nuts, etc.) where required to fasten or support electrical equipment.

F. The required strength of the supporting equipment, and the size and type of anchors, shall be based on the combined weight of conduit, hanger and cables.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-stainless steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, pullout capacities appropriate for supported loads and building materials where used.

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

        1) Hilti Inc.
        2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.

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.

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

        1) B-Line, Inc.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a Division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

3. Concrete Inserts: Stainless 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 stainless-steel springhead type.

7. Hanger Rods: Threaded stainless steel.

H. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceways or cable to be supported.

2.02 EQUIPMENT SUPPORTS AND STANDS

A. Design and construct supporting structures of strength to safety withstand stresses to which subjected and to distribute the load properly. Stainless steel structures shall be used where work is subject to corrosion. Channel dimensions shall be selected for applicable load criteria.

B. Provide supports by one of the following manufacturers, subject to compliance with requirements:
1. Allied Tube & Conduit
2. B-Line
3. Flex-Strut
4. G-Strut
5. Kindorf
6. Thomas & Betts Corporation
7. Unistrut
8. Wesanco

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacing less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps.

3.02 SUPPORT INSTALLATION

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. 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.

C. 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 thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

6. To Light Steel: Sheet metal screws.

7. Items Mounted on Hollow Walls and Noncontractual Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, control panels, pull and junction boxes transformers, and other devices on slotted-channel racks attached to substrate.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 PAINTING

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

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

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

END OF SECTION

SECTION 26 0533.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Flexible metal conduit (FMC).

C. Liquidtight flexible metal conduit (LFMC).

D. Electrical metallic tubing (EMT).

E. Rigid polyvinyl chloride (PVC) conduit.

F. Conduit fittings.

G. Accessories.

1.03 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete encasement of conduits.

B. Section 07 8400 - Firestopping.

C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
   1. Includes additional requirements for fittings for grounding and bonding.

D. Section 26 0529 - Hangers and Supports for Electrical Systems.

E. Section 26 0533.16 - Boxes for Electrical Systems.

F. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

G. Section 26 2100 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.

H. Section 27 1000 - Structured Cabling: Additional requirements for communications systems conduits.

1.04 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).

C. NECA 1 - Standard for Good Workmanship in Electrical Construction.

D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT).

E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC).

F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.

G. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.

H. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.

I. NFPA 70 - National Electrical Code.

J. UL 1 - Flexible Metal Conduit.

K. UL 6 - Electrical Rigid Metal Conduit-Steel.

L. UL 360 - Liquid-Tight Flexible Steel Conduit.

M. UL 514B - Conduit, Tubing, and Cable Fittings.

N. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.

O. UL 797 - Electrical Metallic Tubing-Steel.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
   4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

B. Shop Drawings:
   1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
   2. Include proposed locations of roof penetrations and proposed methods for sealing.

C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:
   1. Under Slab on Grade: Use rigid PVC conduit.
   2. Exterior, Direct-Buried: Use rigid PVC conduit.
   3. Exterior, Embedded Within Concrete: Use rigid PVC conduit.

4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
5. Where rigid polyvinyl (PVC) conduit is provided, use galvanized steel rigid metal conduit elbows for bends.

D. Embedded Within Concrete:
1. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): Use rigid PVC conduit.
2. Within Slab Above Ground (within structural slabs only where approved by Structural Engineer): Use rigid PVC conduit.
3. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.

E. Concealed Within Masonry Walls: Use electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

I. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
1. Locations subject to physical damage include, but are not limited to:
a. Where exposed below 12 feet, except within electrical and communication rooms or closets.

K. Exposed, Exterior: Use galvanized steel rigid metal conduit.

L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.

M. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
1. Maximum Length: 6 feet.

N. Connections to Vibrating Equipment:
1. Dry Locations: Use flexible metal conduit.
2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
3. Maximum Length: 6 feet unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:
a. Transformers.
b. Motors.

2.02 CONDUIT REQUIREMENTS

A. Electrical Service Conduits: Also comply with Section 26 2100.

B. Communications Systems Conduits: Also comply with Section 27 1000.

C. Fittings for Grounding and Bonding: Also comply with Section 26 0526.

D. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

E. Provide products listed, classified, and labeled as suitable for the purpose intended.

F. Minimum Conduit Size, Unless Otherwise Indicated:
1. Branch Circuits: 3/4 inch (21 mm) trade size.
2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
3. Control Circuits: 3/4 inch (21 mm) trade size.
4. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
5. Underground, Interior: 1 inch (27 mm) trade size.
6. Underground, Exterior: 1 inch (27 mm) trade size.

G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:
   1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 FLEXIBLE METAL CONDUIT (FMC)

A. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.

2.05 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.

2.06 ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use compression (gland) type.
      a. Do not use indenter type connectors and couplings.

2.07 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

B. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.08 ACCESSORIES

A. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

C. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

D. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

E. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.

F. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

G. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for the conduit/duct arrangement to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

E. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated without specific routing, determine exact routing required.
   3. Conceal all conduits unless specifically indicated to be exposed.
   4. Conduits in the following areas may be exposed, unless otherwise indicated:
      a. Electrical rooms.
      b. Mechanical equipment rooms.
   5. Unless otherwise approved, do not route conduits exposed:
      a. Across floors.
      b. Across roofs.
      c. Across top of parapet walls.
      d. Across building exterior surfaces.
   6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
   7. Arrange conduit to maintain adequate headroom, clearances, and access.
   8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
   9. Arrange conduit to provide no more than 150 feet between pull points.
   10. Route conduits above water and drain piping where possible.

11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
    a. Heaters.
    b. Hot water piping.
    c. Flues.
14. Group parallel conduits in the same area together on a common rack.

F. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
    a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).

G. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

H. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.

5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
9. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

I. Underground Installation:
1. Provide trenching and backfilling in accordance with Division 31.
2. Provide underground warning tape in accordance with Section 26 0553 along entire conduit length.

J. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Secure conduits to prevent floating or movement during pouring of concrete.

K. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 3000 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

L. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
3. Where conduits are subject to earth movement by settlement or frost.

M. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

N. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

O. Provide grounding and bonding in accordance with Section 26 0526.

P. Identify conduits in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

B. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 0533.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

C. Underground boxes/enclosures.

1.03 RELATED REQUIREMENTS

A. Section 08 3100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0529 - Hangers and Supports for Electrical Systems.

D. Section 26 0533.13 - Conduit for Electrical Systems:
   1. Conduit bodies and other fittings.
   2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.

E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

F. Section 26 2726 - Wiring Devices:
   1. Wall plates.
   2. Additional requirements for locating boxes for wiring devices.

G. Section 27 1000 - Structured Cabling: Additional requirements for communications systems outlet boxes.

1.04 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.

C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.

D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

F. NFPA 70 - National Electrical Code.

G. SCTE 77 - Specification for Underground Enclosure Integrity.

H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.

I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.

J. UL 508A - UL Standard for Safety Industrial Control Panels .

K. UL 514A - Metallic Outlet Boxes.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for outlet and device boxes, junction and pull boxes, cabinets and enclosures, and underground boxes/enclosures.
   1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.

B. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, and underground boxes/enclosures.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

A. General Requirements:
   1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
   2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
   3. Provide products listed, classified, and labeled as suitable for the purpose intended.
   4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
   5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
   1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
   2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
   3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit is used.
   4. Use suitable concrete type boxes where flush-mounted in concrete.

5. Use suitable masonry type boxes where flush-mounted in masonry walls.
6. Use raised covers suitable for the type of wall construction and device configuration where required.
7. Use shallow boxes where required by the type of wall construction.
8. Do not use "through-wall" boxes designed for access from both sides of wall.
9. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
11. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
12. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
13. Minimum Box Size, Unless Otherwise Indicated:
    a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
    b. Communications Systems Outlets: Comply with Section 27 1000.
14. Wall Plates: Comply with Section 26 2726.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
    a. Indoor Clean, Dry Locations: Type 1, painted steel.
    b. Outdoor Locations: Type 3R, painted steel.
3. Junction and Pull Boxes Larger Than 100 cubic inches:
    a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

D. Underground Boxes/Enclosures:
1. Description: In-ground, solid bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
2. Size: As indicated on drawings.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
4. Provide logo on cover to indicate type of service.
5. Applications:
    a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 8 load rating.
    b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 15 load rating.
    c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
6. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive boxes.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide separate boxes for emergency power and normal power systems.

E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

H. Box Locations:
   1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.
   2. Unless dimensioned, box locations indicated are approximate.
   3. Locate boxes as required for devices installed under other sections or by others.
      a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 2726.
      b. Communications Systems Outlets: Comply with Section 27 1000.
   4. Locate boxes so that wall plates do not span different building finishes.
   5. Locate boxes so that wall plates do not cross masonry joints.
   6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
   7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
   8. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
   9. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0533.13.
   10. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
      a. Concealed above accessible suspended ceilings.
      b. Within joists in areas with no ceiling.
      c. Electrical rooms.
      d. Mechanical equipment rooms.

I. Box Supports:
   1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
   3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.

J. Install boxes plumb and level.

K. Flush-Mounted Boxes:
   1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.

2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

L. Install boxes as required to preserve insulation integrity.

M. Underground Boxes/Enclosures:
1. Install enclosure on gravel base, minimum 6 inches deep.
2. Flush-mount enclosures located in concrete or paved areas.
3. Mount enclosures located in landscaped areas with top flush with finished grade.
4. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

N. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

O. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

P. Close unused box openings.

Q. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

R. Provide grounding and bonding in accordance with Section 26 0526.

S. Identify boxes in accordance with Section 26 0553.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 0533
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SUMMARY

A. This Section includes the following for site electrical work:

1. Conduit
2. Junction Boxes
3. Outlet Boxes
4. Pull and Splice Boxes.

B. Refer to Division 26, Section "Hangers and Supports for Electrical Systems".

1.03 SUBMITTALS

A. Product Data: For each type of conduit and box. Include data on features, accessories, and finishes.

1.04 Definitions

A. ARC: Aluminum rigid conduit.

B. EMT: Electromechanical Tubing

C. GRC: Galvanized rigid steel conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquid tight flexible metal conduit

G. PVC GRC: PVC coated galvanized rigid steel conduit

1.05 QUALITY ASSURANCE

A. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 METAL CONDUITS, TUBING, AND FITTINGS

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

1. Allied Tube & Conduit and Calbond, part of Atkore International.

2. O-Z/Gedney.

3. Patriot Aluminum Products, LLC.

4. Perma-Cote; Parma-Cote PVC Coated Conduit.

5. Plasti-Bond; Plasti-Bond Red H20T.

6. Republic Conduit.

7. Southwire Company.

8. Thomas & Betts Corporation.

9. Western Tube and Conduit Corporation.

10. Wheatland Tube Company.

11. Wiremold/Legrand

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.

2. Coating Thickness: 0.040 inch, minimum.

E. EMT: Comply with ANSI C80.3 and UL 797.

F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.

2. Fittings for EMT:

a. Material: Steel
b. Type: Compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

H. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by Authorities Having Jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems; a part of Atkore International.

2. Anamet Electrical, Inc.

3. Arnco Corporation.

4. CANTEX Inc.

5. CertainTeed Corporation.

6. Champion Fiberglass Inc.

7. Condux International Inc.

8. Electri-Flex Company.

9. FRE Composites.

10. Kraloy.

11. Lamson & Sessions; Carlon Electrical Products.

12. Niedax Inc.

13. RACO; Hubbell.

14. United Fiberglass.

B. Listing and Labeling: Monometallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.03 BOXES, ENCLOSURES, AND CABINETS

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

1. Adalet.

2. Crouse-Hinds, an Eaton business; Cooper Crouse-Hinds.

3. EGS/Appleton Electric.

4. Erickson Electrical Equipment Company.

5. Hoffman; a brand of Pentair Equipment Protection.

6. Hubbell Incorporated.

7. Kraloy.

8. O-Z/Gedney.

9. Plasti-Bond; Stahlin Non-Metallic Enclosures.

10. RACO; Hubbell.

11. Thomas & Betts Corporation.

12. Wiremold/Legend.

B. General Requirements for Boxes, Enclosures, and Conduits: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or type 3R with continuous hinge cover with flush latch unless otherwise indicated.

2.04 UNDERGROUND BOXES, UNDERGROUND ENCLOSURES, AND PULL BOXES

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

1. Quazite, Oldcastle or equal.

B. Boxes shall be in sizes shown on drawings or larger if necessary to conform with the requirements of the National Electric Code. Boxes shall be manufactured of polymer concrete with lids that identify the contents of the box. Lids shall be bolt down type.

C. Unless otherwise noted boxes shall be PG style, rated tier 22 minimum.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

A. NEC hazardous locations:

1. Non-corrosive areas: GRC.

2. Corrosive areas: PVC-coated GRC.

3. Boxes and Enclosures: explosion-proof.

B. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: GRC.

2. Underground Conduit: GRC with bitumastic coating, PVC Schedule 80 in gravel or PVC Schedule 40 in reinforced concrete as shown on drawings.

3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

4. Boxes and Enclosures, Above ground: NEMA 250, Type as noted on drawings. If not specifically called out on drawings, NEMA 4X boxes shall be provided. Boxes shall have hinged door and removable subpanel.

5. Outlet and device boxes shall be cast metal.

C. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed: ARC.

2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid or Motor-Driven Equipment): LFMC.

3. Damp or Wet Locations: ARC.

4. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 in damp or wet locations. Boxes shall have hinged door and removable subpanel.

5. Outlet and device boxes shall be cast metal.

D. Minimum Raceway Size:

1. Indoors - 3/4-inch trade size.

2. Outdoors (above Ground) - ¾ -inch trade size.

3. Outdoors (below Ground) – 1 –inch trade size.

E. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. ARC: Use threaded aluminum conduit fittings, unless otherwise indicated.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

3. GRC: Use threaded rigid steel conduit fittings, unless otherwise indicated. Comply with NEMA FB 2.10.

4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

I. Transition from underground with GRC.

3.02 INSTALLATION

A. Comply with NECA 101 for installation requirements except where requirements on Drawings or in this Article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Complete raceway installation before starting conductor installation.

C. Comply with requirements in Section 26 05 29 “Hangers and Supports for Electrical Systems” for hanger and supports.

D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

E. Support conduits within 12 inches of changes in direction and within 12 inches of enclosures to which attached.

F. Conceal conduit within finished walls, ceilings, and floors, unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Raceways Embedded in Slabs:

1. Run conduit 1-inch trade size or larger, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.

H. 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.

I. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

L. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

M. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

N. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

O. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

P. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

Q. Install devices to seal raceways interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where underground service raceway enters a building or structure.

3. Where otherwise required by NFPA 70.

R. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

S. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for suspended luminaries**,** equipment subject to vibration, noise transmission, or movement; and for transformers and motors. Use LFMC.

T. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

U. Horizontally separate boxes mounted on opposite sides of walls so they are in the same vertical channel.

V. Locate boxes so that cover or plate will not span different building finishes.

3.03 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.04 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 0536
CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Metal cable tray systems:
   1. Metal ladder cable tray.
   2. Metal wire mesh/basket cable tray.

1.03 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0529 - Hangers and Supports for Electrical Systems.

D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 27 1000 - Structured Cabling.

1.04 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

B. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction.

D. NEMA VE 1 - Metal Cable Tray Systems.

E. NEMA VE 2 - Cable Tray Installation Guidelines.

F. NFPA 70 - National Electrical Code.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the arrangement of cable tray with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others. Coordinate the work with other trades to avoid installation of obstructions within cable tray required clearances.
   2. Coordinate arrangement of cable tray with the dimensions and clearance requirements of the actual products to be installed.
   3. Coordinate the work with placement of supports, anchors, etc. required for mounting.
   4. Notify of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week prior to commencing work of this section; require attendance of all affected installers. Review proposed routing, sequence of installation, and protection requirements for installed cable tray.

C. Sequencing:
   1. Do not begin installation of cables until installation of associated cable tray run is complete.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable tray system components and accessories. Include dimensions, materials, fabrication details, finishes, and span/load ratings.

B. Shop Drawings: Include dimensioned plan views and sections indicating proposed cable tray routing, required clearances, and locations and details of supports, fittings, building element penetrations, and equipment connections.

C. Project Record Documents: Record actual routing of cable tray and locations of supports.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NEMA VE 2, except do not store cable tray outdoors without cover as permitted in NEMA VE 2.

B. Handle products carefully to avoid damage to finish.

PART 2 PRODUCTS

2.01 CABLE TRAY SYSTEM - GENERAL REQUIREMENTS

A. Provide new cable tray system consisting of all required components, fittings, supports, accessories, etc. as necessary for a complete system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Do not use cable tray for applications other than as permitted by NFPA 70 and product listing/classification.

D. Provide cable tray system and associated components suitable for use at indicated span/load ratings under the service conditions at the installed location.

E. Unless otherwise indicated, specified span/load ratings are based on safety factor of 1.5 and working load only (no additional concentrated static load), with ratings for metal cable tray systems in accordance with NEMA VE 1.

F. Unless otherwise indicated, specified load/fill depths and inside widths are nominal values, with values for metal cable tray systems in accordance with NEMA VE 1 including applicable allowable tolerances.

2.02 METAL CABLE TRAY SYSTEMS

A. Comply with NEMA VE 1.

B. Finishes:
   1. Zinc Electroplated Steel: Comply with ASTM B633.
   2. Mill-Galvanized Before Fabrication (Pre-Galvanized) Steel: Comply with ASTM A653/A653M, G90 coating.

C. Metal Ladder Cable Tray:
   1. Material: Mill-galvanized before fabrication (pre-galvanized) steel.
   2. Load/Fill Depth: As indicated on drawings.
   3. Span/Load Rating: As indicated on drawings.
   4. Rung Spacing: 9 inches on center for straight lengths.
   5. Inside Width: As indicated on drawings.
   6. Inside Radius of Fittings: 12 inches.
   7. Cable tray shall have a black finish.

D. Metal Wire Mesh/Basket Cable Tray:
   1. Material: Zinc electroplated steel or mill-galvanized before fabrication (pre-galvanized) steel.
   2. Tray Depth: As indicated on drawings.
   3. Span/Load Rating: As indicated on drawings.
   4. Mesh Spacing: 2 by 4 inches.
   5. Tray Width: As indicated on drawings.

2.03 SOURCE QUALITY CONTROL

A. Metal Cable Tray: Perform factory design tests in accordance with NEMA VE 1, including electrical continuity and load testing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage cable tray system has been completed.

B. Verify that field measurements are as indicated.

C. Verify that the dimensions and span/load ratings of cable tray system components are consistent with the indicated requirements.

D. Verify that mounting surfaces are ready to receive cable tray and associated supports.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install cable tray in accordance with NECA 1 (general workmanship), and NEMA VE 2.

C. Unless otherwise indicated, arrange cable tray to be parallel or perpendicular to building lines.

D. Arrange cable tray to provide required clearances and maintain cable access.
   1. Minimum Clearance Above and Adjacent to Cable Tray: 12 inches.

E. Install cable tray plumb and level, with sections aligned and with horizontal runs at the proper elevation.

F. Metal Wire Mesh/Basket Cable Tray: Field fabricate fittings in accordance with manufacturer's instructions, using only manufacturer-approved connectors classified for bonding.
   1. Inside Radius of Fittings: 12 inches.

G. Cable Tray Movement Provisions:
   1. Provide suitable expansion fittings where cable tray is subject to movement, including but not limited to:
      a. Where cable tray crosses structural joints intended for expansion.
      b. Long straight cable tray runs in accordance with NEMA VE 2.
   2. Use expansion guides in lieu of hold-down clamps where prescribed in NEMA VE 2.
   3. Set gaps for expansion fittings in accordance with NEMA VE 2.

H. Cable Provisions:
   1. Use suitable fixed barrier strips to maintain separation of cables as indicated and as required by NFPA 70.
   2. Use suitable drop-out fittings or bushings where cables exit cable tray as required to maintain minimum cable bending radius.
   3. Use suitable cable support fittings for long vertical cable tray runs with heavy cables.

I. Provide end closures at unconnected ends of cable tray runs.

J. Cable Tray Support:

1. Use manufacturer's recommended hangers and supports, located in accordance with NEMA VE 2 and manufacturer's requirements, but not exceeding specified span unless otherwise approved by Engineer. Provide required support and attachment in accordance with Section 26 0529, where not furnished by cable tray manufacturer.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

K. Grounding and Bonding Requirements, in Addition to Requirements of Section 26 0526:
1. Comply with grounding and bonding requirements of NEMA VE 2.
2. Metal Cable Tray Systems: Use suitable bonding jumpers or classified connectors to provide electrical continuity.
3. Provide suitable equipment grounding conductor in each cable tray, except where cable tray contains only multiconductor cables with integral equipment grounding conductors. Do not use metal cable tray system as sole equipment grounding conductor.

L. Conduit Termination:
1. Use listed cable tray conduit clamps (evaluated for bonding connection) to terminate conduits at cable tray.
2. Provide insulating bushing at conduit termination to protect cables.
3. Provide independent support for conduit.

M. Cable Installation:
1. Comply with cable installation requirements of NEMA VE 2.
2. Use appropriate cable pulling tools, applied to prevent excessive force on cable tray system and maintain minimum cable bending radius.
3. Use cable clamps or cable ties to fasten conductors/cables to vertical and horizontal runs of cable tray.
   a. Distance Between Fastening Points for Vertical Runs: 18 inches.
   b. Distance Between Fastening Points for Horizontal Runs: As required to maintain spacing and confine conductor/cable within the cable fill area.

N. Penetrations: Install firestopping to preserve fire resistance rating of building elements, using materials and methods specified in Section 07 8400.

O. Identification Requirements, in Addition to Those Specified in Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. Inspect cable tray system for damage and defects.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective cable tray system components.

3.04 ADJUSTING

A. Adjust tightness of mechanical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Remove dirt and debris from cable tray.

B. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.06 PROTECTION

A. Protect cable tray system from subsequent construction operations.

END OF SECTION

SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Underground warning tape.

E. Warning signs and labels.

1.03 RELATED REQUIREMENTS

A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

B. Section 26 0536 - Cable Trays for Electrical Systems: Additional identification requirements for cable tray systems.

C. Section 26 0573 - Power System Studies: Arc flash hazard warning labels.

D. Section 26 2726 - Wiring Devices: Device and wallplate finishes.

E. Section 27 1000 - Structured Cabling: Identification for communications cabling and devices.

1.04 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code.

B. UL 969 - Marking and Labeling Systems.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:

1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
2. Do not install identification products until final surface finishes and painting are complete.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

B. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:
   1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
      a. Switchboards:
         1) Identify ampere rating.
         2) Identify voltage and phase.
         3) Identify power source and circuit number. Include location when not within sight of equipment.
         4) Use identification nameplate to identify main overcurrent protective device.
         5) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
      b. Panelboards:
         1) Identify ampere rating.
         2) Identify voltage and phase.
         3) Identify power source and circuit number. Include location when not within sight of equipment.
         4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
         5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
         6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
      c. Transformers:
         1) Identify kVA rating.
         2) Identify voltage and phase for primary and secondary.
         3) Identify power source and circuit number. Include location when not within sight of equipment.
         4) Identify load(s) served. Include location when not within sight of equipment.
      d. Enclosed switches and motor controllers:
         1) Identify voltage and phase.
         2) Identify power source and circuit number. Include location when not within sight of equipment.
         3) Identify load(s) served. Include location when not within sight of equipment.
      e. Transfer Switches:
         1) Identify voltage and phase.
         2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
         3) Identify load(s) served. Include location when not within sight of equipment.
         4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
   2. Service Equipment:
      a. Use identification nameplate to identify each service disconnecting means.
      b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.

3. Emergency System Equipment:
    a. Use identification nameplate to identify emergency system equipment in accordance with NFPA 70.
    b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
    c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.
4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
5. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
6. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
7. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
8. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
    a. Service equipment.
    b. Elevator control panels.
9. Arc Flash Hazard Warning Labels: Comply with Section 26 0573.

B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
    a. At each source and load connection.
    b. Within boxes when more than one circuit is present.
    c. Within equipment enclosures when conductors and cables enter or leave the enclosure.

C. Identification for Raceways:
1. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
2. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
3. Use underground warning tape to identify underground raceways.

D. Identification for Boxes:
1. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
    a. For exposed boxes in public areas, use only identification labels.

E. Identification for Devices:
1. Identification for Communications Devices: Comply with Section 27 1000.
2. Wiring Device and Wallplate Finishes: Comply with Section 26 2726.
3. Use identification label to identify serving branch circuit for all receptacles and switches.

4. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.

F. Identification for Luminaires:
   1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
   1. Materials:
      a. Indoor Clean, Dry Locations: Use plastic nameplates.
      b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
   2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
   3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
   4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
   5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
   1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
   2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
   1. Minimum Size: 1 inch by 2.5 inches.
   2. Legend:
      a. System designation where applicable:
         1) Emergency Power System: Identify with text "EMERGENCY".
         2) Fire Alarm System: Identify with text "FIRE ALARM".
      b. Equipment designation or other approved description.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height:
      a. System Designation: 1 inch.
      b. Equipment Designation: 1/2 inch.
      c. Other Information: 1/4 inch.
   5. Color:
      a. Normal Power System: White text on black background.
      b. Emergency Power System: White text on red background.
      c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:
   1. Minimum Size: 1 inch by 2.5 inches.
   2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height: 1/4 inch.
   5. Color: Black text on white background unless otherwise indicated.

E. Format for Caution and Warning Messages:

1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Power source and circuit number or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

G. Format for Control Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Load controlled or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

H. Format for Fire Alarm Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Red text on white background.

2.03 WIRE AND CABLE MARKERS

A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

C. Legend: Power source and circuit number or other designation indicated.

D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

E. Minimum Text Height: 1/8 inch.

F. Color: Black text on white background unless otherwise indicated.

2.04 UNDERGROUND WARNING TAPE

A. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

B. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color:
1. Tape for Buried Power Lines: Black text on red background.
2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.05 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
   1. Materials:
      a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
      b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
   2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
   3. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels:
   1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
   2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
   3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   1. Surface-Mounted Equipment: Enclosure front.
   2. Flush-Mounted Equipment: Inside of equipment door.
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Branch Devices: Adjacent to device.
   6. Interior Components: Legible from the point of access.
   7. Conduits: Legible from the floor.
   8. Boxes: Outside face of cover.
   9. Conductors and Cables: Legible from the point of access.
   10. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 0553.13
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SUMMARY

A. This Section includes the following for site electrical work:

1. Identification for raceways.
2. Identification for power and control conductors and communication cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.03 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.04 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labeling.

E. Adhesive – attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL969.

1.05 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 and standards. 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 access panels or similar concealment.

PART 2 - PRODUCTS

2.01 DESCRIPTION

A. Lettering shall include name of equipment, the specific unit number, and any reference to on-off or other instructions that are applicable. Use 1/16" thick material for plates up to 2" x 4". For larger sizes use 1/8" thick material. Lettering shall be condensed gothic. The space between lines shall be equal to the width of the letters. Use 1/4" minimum height letters which occupy four to the inch. Increase letter size to 3/4" on largest plates.

B. Control panels, panelboards, disconnects and motor controllers (including soft starters and variable speed drives) shall be labeled with name designation as shown on drawings with the voltage, phase and frequency. Equipment located more than 8' above floor shall be labeled with minimum 2" high self-sticking markers.

2.02 CONDUCTOR AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with preprinted circuit identification.

C. Labels shall identify the feeder destination and conductor phase in the distribution equipment.

D. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.

F. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

2.03 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape. Tape and ink materials shall be chemically inert, and not subject to degradation when exposed to acids, alkalis, and other destructive materials that may be contained in soils.

1. Not less than 6 inches wide by 4 mils thick.

2. Compounded for permanent direct-burial service.

3. Embedded continuous metallic strip or core.

4. Use red tape inscribed “Electric Line - High Voltage” for power.

5. Use orange colored tape inscribed “communication cable” for telephone, network and other communication media.

2.04 NAMEPLATES, WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting.

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting.

E. 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.

F. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and ultraviolet-resistant seal for label.

G. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with black letters on a white background. Minimum letter height shall be 3/8 inch.

2.05 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.

2. Punched or drilled for mechanical fasteners.

3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.06 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch.

2. Tensile Strength: 50 pounds, minimum.

3. Temperature Range: Minus 40 to plus 185 degrees F.

4. Color: Black, except where used for color-coding.

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.07 RACEWAY LABELS

A. All aboveground raceways shall be labeled. Provide pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the raceway it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

PART 3 - EXECUTION

3.01 APPLICATION

A. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:

1. Fire Alarm System: Red.

2. Fire -Suppression Supervisory and Control System: Red and yellow.

3. Mechanical and Electrical Supervisory System: Green and blue.

4. Telecommunication System: Green and yellow.

5. Control Wiring: Green and red.

B. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

C. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape, aluminum wraparound marker labels, or metal tags. Identify each ungrounded conductor according to source and circuit number.

D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

E. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

G. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

H. 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: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

a. Panelboards, electrical cabinets, and enclosures.
b. Disconnect switches.
c. Motor drives.
d. Push-button stations.
e. Monitoring and control equipment.
f. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.02 INSTALLATION

A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Apply identification devices to surfaces that require finish after completing finish work.

C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

D. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

E. Nameplates shall be secured to the front upper trim for panelboards and to the front doors of controls and safety switches with brass #10-24 round head screws and brass nuts.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. 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.

2. Colors for 120/240-V, 3 phase, 4 wire System (Delta High Leg)
   a. Phase A: Black.
   b. Phase B: Orange.
   c. Phase C: Red.
   d. Neutral: White.

3. Colors for 480/277-V Circuits:
   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.
   d. Neutral: Gray or White

4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches 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.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

3.03 PANELBOARD SCHEDULES

A. Neatly type panel board schedules and provide inside protective Plexiglas windows on the inside of panel board doors. Space and spare positions shall be indicated by neatly printing using an erasable pencil for ease of future changes.

END OF SECTION

SECTION 26 0573
POWER SYSTEM STUDIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Short-circuit study.

B. Protective device coordination study.

C. Arc flash and shock risk assessment.
   1. Includes arc flash hazard warning labels.

D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.03 RELATED REQUIREMENTS

A. Section 26 0553 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.

B. Section 26 2100 - Low-Voltage Electrical Service Entrance.

C. Section 26 2413 - Switchboards.

D. Section 26 2416 - Panelboards.

E. Section 26 2813 - Fuses.

F. Section 26 2816.16 - Enclosed Switches.

G. Section 26 2913 - Enclosed Controllers.

1.04 REFERENCE STANDARDS

A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.

B. IEEE 141 - IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants.

C. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

D. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis.

E. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems.

F. IEEE 1584 - IEEE Guide for Performing Arc Flash Hazard Calculations.

G. NEMA MG 1 - Motors and Generators.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

I. NFPA 70 - National Electrical Code.

J. NFPA 70E - Standard for Electrical Safety in the Workplace.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
   2. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Submit study reports prior to or concurrent with product submittals.
   2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.

1.06 SUBMITTALS

A. Study preparer's qualifications.

B. Field testing agency's qualifications.

C. Study reports, stamped or sealed and signed by study preparer.

D. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
   1. Include characteristic time-current trip curves for protective devices.
   2. Include impedance data for engine generators.
   3. Identify modifications made in accordance with studies that:
      a. Can be made at no additional cost to Owner.
      b. As submitted will involve a change to the contract sum.

E. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.

F. Field quality control reports.

G. Certification that field adjustable protective devices have been set in accordance with requirements of studies.

H. Project Record Documents: Revise studies as required to reflect as-built conditions.
   1. Include hard copies with operation and maintenance data submittals.
   2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.07 POWER SYSTEM STUDIES

A. Scope of Studies:
   1. Perform analysis of new electrical distribution system as indicated on drawings.
   2. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
   3. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.

B. General Study Requirements:
   1. Comply with NFPA 70.
   2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.

C. Data Collection:
   1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
      a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
         1) Obtain up-to-date information from Utility Company.
         2) Utility Company: As indicated on drawings.
      b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.

c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
e. Protective Devices:
1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.

D. Short-Circuit Study:
1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
a. Maximum utility fault currents.
b. Maximum motor contribution.
c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

E. Protective Device Coordination Study:
1. Comply with applicable portions of IEEE 242 and IEEE 399.
2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
3. Analyze protective devices and associated settings for suitable margins between time-current curves to achieve full selective coordination while providing adequate protection for equipment and conductors.

F. Arc Flash and Shock Risk Assessment:
1. Comply with NFPA 70E.
2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
3. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
a. Maximum and minimum utility fault currents.
b. Maximum and minimum motor contribution.
c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

G. Study Reports:
1. General Requirements:
a. Identify date of study and study preparer.
b. Identify study methodology and software product(s) used.
c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.

d. Identify base used for per unit values.
e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
f. Include conclusions and recommendations.

2. Short-Circuit Study:
   a. For each scenario, identify at each bus location:
      1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
      2) Fault point X/R ratio.
      3) Associated equipment short circuit current ratings.
   b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
3. Protective Device Coordination Study:
   a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
   b. For each graph include (where applicable):
      1) Partial single-line diagram identifying the portion of the system illustrated.
      2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
      3) Conductors: Damage curves.
      4) Transformers: Inrush points and damage curves.
      5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
      6) Motors: Full load current, starting curves, and damage curves.
      7) Capacitors: Full load current and damage curves.
   c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
      1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
      2) Include ground fault pickup and delay.
      3) Include fuse ratings.
      4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
   d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.
4. Arc Flash and Shock Risk Assessment:
   a. For the worst case for each scenario, identify at each bus location:
      1) Calculated incident energy and associated working distance.
      2) Calculated arc flash boundary.
      3) Bolted fault current.
      4) Arcing fault current.
      5) Clearing time.
      6) Arc gap distance.
   b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.
   c. Include recommendations for reducing the incident energy at locations where the calculated maximum incident energy exceeds 8 calories per sq cm.

1.08 QUALITY ASSURANCE

A. Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum five years experience in the preparation of studies of similar type and complexity using specified computer software.

B. Field Testing Agency Qualifications: Independent testing organization specializing in testing, analysis, and maintenance of electrical systems with minimum five years experience; NETA Accredited Company.

C. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.

PART 2 PRODUCTS

2.01 ARC FLASH HAZARD WARNING LABELS

A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
   1. Materials: Comply with Section 26 0553.
   2. Minimum Size: 4 by 6 inches.
   3. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
      a. Include orange header that reads "WARNING".
      b. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.
      c. Include the following information:
         1) Arc flash boundary.
         2) Available incident energy and corresponding working distance.
         3) Site-specific PPE (personnel protective equipment) requirements.
         4) Nominal system voltage.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install arc flash warning labels in accordance with Section 26 0553.

3.02 FIELD QUALITY CONTROL

A. Provide the services of field testing agency to perform inspection, testing, and adjusting.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Adjust equipment and protective devices for compliance with studies and recommended settings.

D. Notify Architect of any conflicts with or deviations from studies. Obtain direction before proceeding.

3.03 CLOSEOUT ACTIVITIES

A. Training: Include as part of the base bid training for Owner's personnel on electrical safety pertaining to arc flash and shock hazards.
   1. Use site-specific arc flash and shock risk assessment report as training reference, supplemented with additional training materials as required.

END OF SECTION

SECTION 26 0583
WIRING CONNECTIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Electrical connections to equipment.

1.03 RELATED REQUIREMENTS

A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.

B. Section 26 0533.13 - Conduit for Electrical Systems.

C. Section 26 0533.16 - Boxes for Electrical Systems.

D. Section 26 2726 - Wiring Devices.

E. Section 26 2816.16 - Enclosed Switches.

F. Section 26 2913 - Enclosed Controllers.

1.04 REFERENCE STANDARDS

A. NEMA WD 1 - General Color Requirements for Wiring Devices.

B. NEMA WD 6 - Wiring Devices - Dimensional Specifications.

C. NFPA 70 - National Electrical Code.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
   2. Determine connection locations and requirements.

1.06 SUBMITTALS

A. Product Data: Provide wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
   1. Colors: Comply with NEMA WD 1.
   2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
   3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

B. Disconnect Switches: As specified in Section 26 2816.16 and in individual equipment sections.

C. Wiring Devices: As specified in Section 26 2726.

D. Flexible Conduit: As specified in Section 26 0533.13.

E. Wire and Cable: As specified in Section 26 0519.

F. Boxes: As specified in Section 26 0533.16.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION

SECTION 26 0923
LIGHTING CONTROL SYSTEM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Distributed Digital Lighting Control System: System includes
   1. Distributed Digital Lighting Controls
   2. Relay Panels

1.03 RELATED SECTIONS

A. Section 26 5000 - Interior Lighting

B. Section 26 5600 - Exterior Lighting

C. Section 26 2726 - Wiring Devices

D. Division 28 - Security Management System for Touchscreen Control Integration

1.04 REFERENCES

A. NFPA 70 - National Electrical Code; National Fire Protection Association.

B. NEMA - National Electrical Manufacturers Association

C. FCC emission standards

D. UL - Underwriters Laboratories, Inc. Listings

E. ULC - Underwriter Laboratories of Canada Listings

1.05 DESIGN / PERFORMANCE REQUIREMENTS

A. Digital Lighting Management System shall accommodate the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches and accessories that suit the required lighting and electrical system parameters.

B. System shall conform to requirements of NFPA 70.

C. System shall comply with FCC emission standards specified in part 15, sub-part J for commercial and residential application.

D. System shall be listed under UL sections 916 and/or 508.

1.06 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Catalog sheets and specifications.
   2. Ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

B. Shop Drawings: Wiring diagrams for the various components of the System specified including:
   1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed.
   2. Show location of all devices, including at minimum sensors, load controllers, and switches/dimmers for each area on reflected ceiling plans.
   3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
   4. Network riser diagram including floor and building level details. Include network cable specification. Illustrate points of connection to integrated systems. Coordinate integration

with mechanical and/or other trades.

C. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

D. Closeout Submittals:
   1. Project Record Documents: Record actual installed locations and settings for lighting control devices.
   2. Operation and Maintenance Manual:
      a. Include approved Shop Drawings and Product Data.
      b. Include Sequence of Operation, identifying operation for each room or space.
      c. Include manufacturer's maintenance information.
      d. Operation and Maintenance Data: Include detailed information on device programming and setup.
      e. Include startup and test reports.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of 10 years documented experience.

B. Installer Qualifications: Company certified by the manufacturer and specializing in installation of networked lighting control products with minimum three years documented experience.

C. System Components: Demonstrate that individual components have undergone quality control and testing prior to shipping.

1.08 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to commencing Work of this section. Meeting to be attended by Contractor, Architect, system installer, factory authorized manufacturer's representative, Owner, and representative of all trades related to the system installation.

B. Review installation procedures and coordination required with related Work and the following:
   1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
   2. Review the specifications for low voltage control wiring and termination.
   3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
   4. Discuss requirements for integration with other trades

C. Inspect and make notes of job conditions prior to installation:
   1. Record minutes of the conference and provide copies to all parties present.
   2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.
   3. Installation shall not begin until all outstanding issues are resolved to the satisfaction of the Architect.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation

1.10 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   1. Ambient temperature: 32 to 104 degrees F (0 to 40 degrees C).
   2. Relative humidity: Maximum 90 percent, non-condensing.

1.11 WARRANTY

A. Products Warranty: Manufacturer shall provide a 5 year limited warranty on products within this installation, except where otherwise noted, and consisting of a one for one device replacement.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Wattstopper
   1. Or approved equal.

2.02 DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM

A. System General: Provide a Legrand Wattstopper, Provide Digital Lighting Management System (DLM) complete with all necessary enclosures, wiring, and system components to ensure a complete and properly functioning system as indicated on the Drawings and specified herein. If a conflict is identified, between the Drawing and this Specification, contact the Architect for clarification prior to proceeding.
   1. Provide manual-on occupancy/vacancy sensors as indicated on the drawings.

B. Equipment Required: Lighting Control and Automation system as defined under this section covers the following equipment.
   1. Digital Lighting Management (DLM) local network: Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
   2. Digital Room Controllers: Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.
   3. Digital Occupancy Sensors: Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
   4. Digital Switches: Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
   5. Configuration Tools: Handheld remote for room configuration and relay panel programming provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away.
   6. Digital Lighting Management (DLM) segment network: Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded) to connect multiple DLM local networks for centralized control.
   7. Segment Manager: BACnet MS/TP-based controller with web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
   8. Programming and Configuration Software: Optional PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.
   9. Digital Lighting Management Relay Panel and Zone Controller: Provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS). Zero relay Zone Controller primarily supports Digital Fixture Controller applications.

C. Local Network LMRJ-Series: DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.

1. Features of the DLM local network include:
    a. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
    b. Simple replacement of any device in the local DLM network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.
    c. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
    d. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
2. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.
3. If manufacturer's pre-terminated Cat5e cables are not used for the installation each cable must be individually tested and observed by authorized service representative following installation.

2.03 DIGITAL LOAD CONTROLLERS (ROOM AND FIXTURE CONTROLLERS)

A. Digital Load Controllers: Digital controllers for lighting zones and fixtures automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting control requirements. Controllers are simple to install, and do not have dip switches/potentiometers, or require special configuration for standard Plug n' Go applications. Control units include the following features
    1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
    2. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
    3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned starting with load 1 to a maximum of 64, assigned based on each controller's device ID's from highest to lowest.
    4. Device Status LEDs to indicate:
        a. Data transmission
        b. Device has power
        c. Status for each load
        d. Configuration status
    5. Quick installation features including:
        a. Standard junction box mounting
        b. Quick low voltage connections using standard RJ-45 patch cable
    6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
        a. Turn on to 100 percent
        b. Turn off
        c. Turn on to last level
    7. Each load be configurable to operate in the following sequences based on occupancy:
        a. Auto-on/Auto-off (Follow on and off)
        b. Manual-on/Auto-off (Follow off only)
    8. Polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.

9. BACnet object information shall be available for the following objects:
    a. Load status
    b. Schedule state, normal or after-hours
    c. Demand Response enable and disable
    d. Room occupancy status
    e. Total room lighting and plug loads watts
    f. Electrical current
    g. Total watts per controller
    h. Total room watts/sq ft.
    i. Force on/off all loads
10. UL 2043 plenum rated
11. Manual override and LED indication for each load
12. Zero cross circuitry for each load
13. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
14. Dimming Room Controllers shall share the following features:
    a. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
    b. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
    c. The following dimming attributes may be changed or selected using a wireless configuration tool:
        1) Establish preset level for each load from 0-100 percent
        2) Set high and low trim for each load
        3) Initiate lamp burn in for each load of either 0, 12 or 100 hours
    d. Override button for each load provides the following functions:
        1) Press and release for on/off control
        2) Press and hold for dimming control
    e. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
    f. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
    g. Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.
    h. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

B. On/Off/0-10V Dimming Enhanced Room Controllers shall include:
    1. Dual voltage (120/277 VAC, 60 Hz) capable or 347 VAC, 60 Hz. 120/277 volt models rated for 20A total load; 347 volt models rated for 15A total load
    2. Built in real time current monitoring
    3. One, two or three relays configurations
    4. Smart 250 mA switching power supply
    5. Four RJ-45 DLM local network ports. Provide integral strain relief
    6. One dimming output per relay

a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting (LMRC-110 series and 210 series).

7. Legrand Wattstopper product numbers: LMRC-211, LRMC-212, LRMC-213.

2.04 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

A. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
   1. Digital calibration and pushbutton configuration for the following variables:
      a. Sensitivity, 0-100 percent in 10 percent increments
      b. Time delay, 1-30 minutes in 1 minute increments
      c. Test mode, Five second time delay
      d. Detection technology, PIR, Ultrasonic or Dual Technology activation and/or re-activation.
      e. Walk-through mode
   2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
   3. Programmable control functionality including:
      a. Each sensor may be programmed to control specific loads within a local network.
      b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
      c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
      d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
      e. Ultrasonic and Passive Infrared
      f. Ultrasonic or Passive Infrared
      g. Ultrasonic only
      h. Passive Infrared only
      i. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
   4. One or two RJ-45 port(s) for connection to DLM local network.
   5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
   6. Device Status LEDs, which may be disabled for selected applications, including:
      a. PIR detection
      b. Ultrasonic detection
      c. Configuration mode
      d. Load binding
   7. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
   8. Manual override of controlled loads.
   9. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.

B. BACnet object information shall be available for the following objects:
   1. Detection state
   2. Occupancy sensor time delay

3. Occupancy sensor sensitivity, PIR and Ultrasonic

C. Units shall not have any dip switches or potentiometers for field settings

D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

E. Legrand Wattstopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

2.05 DIGITAL WALL SWITCHES

A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
   1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
   2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
   3. Configuration LED on each switch that blinks to indicate data transmission.
   4. Load/Scene Status LED on each switch button with the following characteristics:
      a. Bi-level LED
      b. Dim locator level indicates power to switch
      c. Bright status level indicates that load or scene is active
      d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
   5. Programmable control functionality including:
      a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
      b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
   6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.

B. BACnet object information shall be available for the following objects:
   1. Switch lock control
   2. Switch lock status

C. Two RJ-45 ports for connection to DLM local network.

D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.

E. Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
   1. Individual button function may be configured to Toggle, On only or Off only.
   2. Individual scenes may be locked to prevent unauthorized change.
   3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
   4. Ramp rate may be adjusted for each dimmer switch.
   5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
   6. Legrand Wattstopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.06 HANDHELD CONFIGURATION TOOLS

A. Provide a wireless configuration tool to facilitate customization of DLM local networks using two-way infrared communications, and/or PC software that connects to each local network via a USB interface.

B. Features and functionality of the wireless configuration tool shall include but not be limited to:
   1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
   2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
   3. Must be able to read and modify parameters for load controllers and relay panels, occupancy sensors, wall switches, daylighting sensors, network bridges, and identify DLM devices by type and serial number.
   4. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.
   5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
   6. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.
   7. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
   8. Verify status of building level network devices.

C. Legrand Wattstopper Product Numbers: Handheld LMCT-100

2.07 DLM SEGMENT NETWORK

A. Provide a segment network using linear topology, BACnet-based MS/TP subnet to connect DLM local networks (rooms) and LMCP relay panels for centralized control.
   1. Each connected DLM local network shall include a single network bridge (LMBC-300), and the network bridge is the only room-based device that is connected to the segment network.
   2. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate "in" and "out" terminations, for segment network connections.
   3. Segment network utilizes 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. Maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.
   4. Network wire jacket is available in high visibility green, white, or black.
   5. Substitution of manufacturer-supplied cable is not permitted and may void the warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer's specific requirements.
   6. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.
   7. Segment networks shall be capable of connecting to any of the following: BACnet-compliant BAS (provided by others) directly via MS/TP, or BACnet/IP via an NB-ROUTER or LMSM Unit. Systems whose room-connected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable

B. Legrand Wattstopper Product Number: LM-MSTP, LM-MSTP-W, LM-MSTP-B, LM-MSTP-DB

2.08 LMCP-10V ON/OFF/0-10V LIGHTING CONTROL PANELS AND LMZC ZONE CONTROLLER

A. Hardware: Provide LMCP lighting control panels with On/Off relays and 0-10V control capability in the locations and capacities as indicated on the Drawing and schedules. Each panel shall be of modular construction and consist of the following components:

1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 – 8, 1 – 24, or 1 – 48 relays and 0-10V dimming outputs. 24 and 48 size panels shall also have space for up to 6 four-pole contactors.
2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. LMCP-10V panel cover shall have a hinged and lockable door to restrict access to line voltage section of the panel.
3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. Interior construction shall provide isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. Interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, individually replaceable latching type relays. For each relay a 0-10V output shall be available on the relay driver board. Panel interiors shall include the following features:
    a. Removable, plug-in terminal blocks with connections for all 0-10V wiring terminations.
    b. Override pushbutton (providing On/Off and Dimming capability) and LED ON/OFF status for each relay.
    c. Digital inputs (four RJ-45 jacks) shall support all Wired DLM digital switches, dimmers, input and/or output modules, daylighting sensors; occupancy sensors, and additional load controllers. Inputs are divided into two separate digital networks (A and B), each capable of supplying 250mA to connected devices.
    d. Relay and 0-10V output states shall be available to external control devices and systems via BACnet.
    e. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large groups of loads are to be controlled together.
    f. Group and pattern control of relays shall be provided through a simple interface from a handheld IR programmer. Each relay and 0-10V output can be associated with a group for direct on/off or dimming control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
    g. Relay group status for shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
4. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
    a. Electrical:
        1) 30 amp ballast at 277V, 20 amp ballast at 347V
        2) 16 amp E-Ballast at 120V, 10 amp E-Ballast at 277V
        3) 20 amp tungsten at 120V
        4) 30 amp resistive at 347V
        5) HP motor at 120V
        6) 20 amp at 120V for Receptacle Loads
        7) 14,000 amp short circuit current rating (SCCR) at 347V
        8) Relays shall be UL 20 listed for control of plug loads
    b. Mechanical:
        1) Replaceable, 1/2 inch KO mounting with Class 2 wire harness and single 5-pin phenolic connector.
        2) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
        3) Dual line and load terminals each support two #12 - #14 solid or stranded conductors.
        4) Capable of to 300,000 mechanical on/off cycles.
        5) Internal ferrite to prevent electrical noise on low voltage wires

6) Isolated low voltage contacts provide for relay status feedback and pilot light indication

5. A 0-10V output shall be provided per relay. This output is linked to its individual relay so they are controlled together automatically. The 0-10V signal from the panel shall meet requirements of NEMA ANSI C82.11-2011 - Annex A allowing it to control any fixtures providing a 0-10V control signal such that 10V or higher will drive the light to maximum, and 1V or less will drive the light to minimum output. A linear dimming curve is used between these levels.
6. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
7. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic bypass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700. Additionally, Relay Driver Cards providing 0-10V control shall automatically open up the 0-10V single on loss of normal power, ensuring any controlled fixture powered by a different source shall go full on.
8. Integral system clock shall provide scheduling capabilities for panel-only projects without DLM segment networks or BAS control.
    a. Each panel shall include digital clock capability able to issue system wide automation commands to up to 11 other panels for a total of 12 networked lighting control panels. Clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
    b. Clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.
    c. Clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery backup for clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
    d. Clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
        1) Scheduled ON (or Goto Level) / OFF
        2) Manual ON / Scheduled OFF
        3) Astro ON / OFF (or Photo ON / OFF)
        4) Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
    e. User interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100-2) or Front End System Software package.
    f. Clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
    g. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
9. Lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a front end network controller, via the room to room segment network.

10. Lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices by incorporating a digital Wired Network Bridge on the panel's intelligence board. All features associated with the LMBC-300 Wired Network Bridge shall extend to the panel and its controlled loads, and all devices connected to the panel by Cat 5e local IRB network. Digital communications shall be RS485 MS/TP-based using the BACnet protocol.
11. In addition to the LMCP Relay Panels, an LMZC Zone Controller panel shall be available. This panel is designed for applications where LMFC-011 Fixture Controllers or other distributed load controllers are used to switch and/or dim the controlled loads. Key similarities to and differences from the LMCP panel design shall include:
    a. Use the same intelligence board as the LMCP relay panel.
    b. Shall not include relay driver boards, relays, or 0-10V outputs.
    c. Have a removable interior section to facilitate installation, and a Tub/Cover. Cover is for surface mounting applications only.
    d. Tub shall have two interior KOs to allow installation of LMPB-100 Power Boosters. Each installed Power Booster can provide an additional 150 mA for either of the two available DLM local networks provided by the LMZC.
    e. All programming and networking (whether DLM Local Network and/or Segment Network) capabilities in the LMZC Zone Controller shall be similar to capabilities for LMCP relay panels, except for functions designed for panel-mounted HDR relays and 0-10V outputs.
12. To aid in project start up, if LMFC Fixture Controllers are connected to an LMZC Zone Controller, Plug 'n Go™ automatic configuration will establish a unique sequence of operation when any digital occupancy sensor detects motion.
13. For retrofit applications, or where direct low voltage override switches and pilot contacts are required, an LMCP panel with only On/Off capability can be provided using On/Off relay driver cards. These cards are NOT capable of providing 0-10V outputs, but will include a removable terminal that provides a direct wired switch inputs associated with each relay (2-wire momentary switches only) and a pilot output.
14. Wattstopper Product Number: On/Off/0-10V Relay Panels: LMCP-8-10V, LMCP-24-10V, LMCP-48-10V; On/Off Only Relay Panels: LMCP8, LMCP24 or LMCP48; Zone Controller: LMZC-301.

B. User Interface: Each lighting control panel system shall be supplied with at least one handheld configuration tool (LMCT-100-2). As a remote programming interface, the configuration tool shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. User interface shall have the following panel-specific functions as a minimum:
    1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
    2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
    3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
    4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive and shall be configurable as to whether the event is active

on holidays.

5. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.
6. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.
7. Wattstopper Product Number: LMCT-100-2

2.09 FRONT END NETWORK CONTROLLER

A. For networked applications, the Digital Lighting Management system can include one or more Front End Network Controllers to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser.

B. Each Network Controller shall have integral support for two segment networks. Segment networks may alternately be connected to the Network Controller via external BACnet-to-IP interface routers, Border Routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the Drawings.

C. Operational features of the Network Controller shall include the following:
   1. Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
   2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser. The Network Controller shall not require installation of any lighting control software on an end-user PC.
   3. Log in security capable of restricting some users to view-only or other limited operations.
   4. Some Network Controller shall include two main sets of interface screens – those used to initially configure the unit (referred to as the config screens), and a those used to allow users to dynamic monitor the performance of their system, and provide a centralized scheduling interface. Capabilities using the Config Screens shall include:
      a. Automatic discovery of DLM devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.
      b. Allow information for all discovered DLM devices to be imported into the Network Controller via a single XML based site file from the Wattstopper LMCS Software, significantly reducing the time needed to make a system usable by the end user. Importable information can include text descriptions of every DLM component and individual loads, and automatic creation of room location information and overall structure of DLM network. Info entered into LMCS should not have to be re-entered manually via keystrokes into the Network Controller
      c. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
      d. Ability to view and modify DLM device operational parameters. It shall be possible to set device parameters independently for normal hours and after-hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.
      e. Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the Network Controller: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Network Controller Group schedule state control. Any of above items

shall be capable of being moved into an “Export Table” that will provide any integrator with only the data they need, and by using the Export Table effectively create a firewall between the integrator’s request for info and the overall system performance.

5. Capabilities using the Network Controllers Dashboard Screens shall include:
    a. A dynamic “tile” based interface that allows easy viewing of each individual room’s lighting and plug load power consumption, and lighting and plug load power density (power consumption information requires Enhanced DLM Room and Plug Load Controllers with integral current transducers or voltage and current measurement).Tiles will be automatically organized according to location so a single tile for the building summarizes all information for tiles beneath it on every floor, in every area, in every room. Tiles use three color coded energy target parameters, allowing an owner to quickly identify rooms that are not performing efficiently. Tiles for rooms with occupancy sensors shall include an icon to indicate whether that room is occupied. Tiles shall be clickable, and when clicked the underlying hierarchical level of tiles shall become visible. Tile interface shall be accessible via mouse, or touch screen devices. Tiles shall be created automatically by the Network Controller, based on the information found during the device discovery and/or information included in a file imported in from LMCS (such as tagged descriptions for each room) without any custom programming.
    b. Ability to set up schedules for DLM local networks (rooms) and panels. Schedules shall be capable of controlling individual rooms with either on/off or normal hours/after hours set controlled zones or areas to either a normal hours or after hours mode of operation. Support for annual schedules, holiday schedules and unique date-bound schedules, as well as astro On or astro Off events with offsets. Schedules shall be viable graphically as time bars in a screen set up to automatically show scheduled events by day, week or month.
    c. For fixtures that are accessible via the Segment Network, and have CCT capability as specified under paragraph Digital Wall Switch and Timer For Correlated Color Temperature, the Network Controller will provide schedule functionality similar to the CCT Wall Timer, allowing all CCT fixtures across the entire facility to be scheduled together.
    d. Ability to provide a simple time vs. power graph based on information stored in each Network Controller’s memory (typically two to three days’ data).
6. If indicated by the Drawings, Network Controllers shall be integrated into a larger overall network by the addition of a Network Supervisor package. The Supervisor is a server level computer running a version of the Network Controller software with dedicated communication and networking capability, able to pull information automatically from each individual Network Controller. By using a Supervisor, information for individual Network Controllers can be accessed and stored on the Supervisor’s hard drive, eliminating the risk of data being overwritten after a few days because of Network Controller memory limits.
7. Front End Network Controllers shall allow access and control of the overall system database. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.

D. The Network Controller shall be capable of supporting multiple DLM Networks/Rooms:
1. LMJA-8125 expandible to 4 Segments, 40 Network Bridges per segment for a maximum of 125 Rooms / Bridges and 2000 DLM Devices.
2. LMJA-8300 expandible to 4 Segments, 40 Network Bridges per segment for a maximum of 300 Rooms / Bridges and 2000 DLM Devices.
    a. Additional Segments may be added as long as the Bridge and Total Devices are not violated. The addition of NB Routers and NB Switches in a larger LMNC cabinet will facilitate adding Segments.

b. Add any additional LMNC cabinets to expand system parameters.

E. Wattstopper Product Numbers: LMJA-8125, LMJA-8300, LM-SUPERVISOR, NB-ROUTER, NB-SWITCH, NB-SWITCH-8, NB-SWITCH-16.

2.10 PROGRAMMING, CONFIGURATION AND DOCUMENTATION SOFTWARE

A. PC-native application for optional programming of detailed technician-level parameter information for all DLM products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room when connected via the optional LMCI-100 USB programming adapter, or globally for many segment networks simultaneously utilizing standard BACnet/IP communication.

B. Additional parameters exposed through this method include but are not limited to:
   1. Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.
   2. Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.
   3. Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.
   4. Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.
   5. Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.
   6. Load control polarity reversal so that on events turn loads off and vice versa.
   7. Per-load DR (demand response) shed level in units of percent.
   8. Load output pulse mode in increments of 1second.
   9. Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.

C. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:
   1. Device list report: All devices in a project listed by type.
   2. Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.
   3. BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.
   4. Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.
   5. Device parameter report: Per-room lists of all configured parameters accessible via hand held IR programmer for use with O&M documentation.
   6. Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100 percent, 2 = all loads 75 percent, 3 = all loads 50 percent, 4 = all loads 25 percent, 5-16 = same as scene 1).
   7. Occupancy sensor report: Basic settings including time delay and sensitivities for all occupancy sensors.

D. Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations:
   1. Set, copy/paste an entire project site of sensor time delays.
   2. Set, copy/paste an entire project site of sensor sensitivity settings.
   3. Search based on room name and text labels.
   4. Filter by product type (i.e. LMRC-212) to allow parameter set by product.

5. Filter by parameter value to search for product with specific configurations.

E. Network-wide firmware upgrading remotely via the BACnet/IP network.
   1. Mass firmware update of entire rooms.
   2. Mass firmware update of specifically selected rooms or areas.
   3. Mass firmware upgrade of specific products

F. Legrand Wattstopper Product Number: LMCS-100, LMCI-100

2.11 SECURITY MANAGEMENT SYSTEM - TOUCHSCREEN CONTROL

A. Lighting, receptacle and television circuits shall be controlled via Security Management System touchscreen controls where indicated on the drawings.
   1. The operation shall require an operator to touch the assigned/associated Token/Icon to cause the associated circuit relay to toggle between the energized and de-energized state thereby turning on or off the associated circuit. The Token/Icon shall annunciate the current state of the controlled circuits.
   2. The interface between the Security Management System and the controlled circuits shall be implemented through the use Lighting Control Panel (LCP) relays installed in series with controlled electrical circuits.

B. The touchscreen controls shall be provided by the Security Management System provider.
   1. Coordinate all interfacing and programming requirements with Security Management System provider prior to installation. Provide all equipment as required for a complete operating system.

PART 3 EXECUTION

3.01 PREPARATION

A. Do not begin installation until measurements have been verified and work areas have been properly prepared.

B. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Verify that required pre-installation meeting specified in Part 1 of this specification has been completed, recorded meeting minutes have been distributed and all outstanding issues noted have been resolved prior to the start of installation.

3.02 INSTALLATION

A. Install system in accordance with the approved system shop drawings and manufacturer's instructions.

B. All low-voltage and line-voltage wiring shall be installed in conduit.

C. Install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors.
   1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.
   2. If fixtures have internal DLM Control Modules, ensure that they are also connected with Cat 5e cable.
   3. Low voltage wiring topology must comply with manufacturer's specifications.
   4. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.

D. All line voltage connections shall be tagged to indicate circuit and switched legs.

E. Test all devices to ensure proper communication.

F. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.

G. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
   1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
   2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
   3. Load Parameters (e.g. blink warning, etc.)

H. Post start-up tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy. Provide a detailed report to the Architect / Owner of post start-up activity.

I. Tighten all panel Class I conductors from both circuit breaker and to loads to torque ratings as marked on enclosure UL label.

J. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.

K. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.

L. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to room controllers.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Notify Architect and Manufacturer in writing a minimum of 3 weeks prior to system start-up and testing.

B. Tests and Inspections: Manufacturer's service representative shall perform the following inspections and prepare reports.
   1. Verify Class I and II wiring connections are terminated properly by validating system performance.
   2. Set IP addresses and other network settings of system front end hardware per facilities IT instructions.
   3. Verify / complete task programming for all switches, dimmers, time clocks, and sensors.
   4. Verify that the control of each space complies with the Sequence of Operation.
   5. Correct any system issues and retest..

C. Provide a report in table format with drawings, or using a software file that can be opened in the manufacturer's system software including each room or space that has lighting control installed. Indicate the following:
   1. Date of test or inspection.
   2. Loads per space, or Fixture Address identification.
   3. Quantity and Type of each device installed
   4. Reports providing each device's settings.

3.04 DEMONSTRATION AND TRAINING

A. Before Substantial Completion, arrange and provide a one-day Owner instruction period to designated Owner personnel. Set-up, starting of the lighting control system and Owner instruction includes:
   1. Confirmation of entire system operation and communication to each device.
   2. Confirmation of operation of individual relays, switches, and sensors.
   3. Confirmation of system Programming, photocell settings, override settings, etc.

4. Provide training to cover installation, programming, operation, and troubleshooting of the lighting control system.

3.05 PRODUCT SUPPORT AND SERVICE

A. Factory telephone support shall be available at no cost to the Owner following acceptance. Factory assistance shall consist of assistance in solving application issues pertaining to the control equipment.

END OF SECTION

SECTION 26 2100
LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Electrical service requirements.

1.03 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Materials and installation requirements for cast-in-place concrete equipment pads.

B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.

C. Section 26 0526 - Grounding and Bonding for Electrical Systems.

D. Section 26 0529 - Hangers and Supports for Electrical Systems.

E. Section 26 0533.13 - Conduit for Electrical Systems.

F. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

G. Section 26 2413 - Switchboards: Service entrance equipment.

1.04 DEFINITIONS

A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in NFPA 70, and as designated by the Utility Company.

1.05 REFERENCE STANDARDS

A. IEEE C2 - National Electrical Safety Code.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction.

C. NFPA 70 - National Electrical Code.

1.06 ADMINISTRATIVE REQUIREMENTS

A. No later than two weeks following date of the Agreement, notify Utility Company of anticipated date of service.

B. Coordination:
   1. Verify the following with Utility Company representative:
      a. Utility Company requirements, including division of responsibility.
      b. Exact location and details of utility point of connection.
      c. Utility easement requirements.
      d. Utility Company charges associated with providing service.
   2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.
   3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.

D. Utility Company charges associated with providing permanent service to be paid by Contractor..

E. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Utility Company representative.

F. Scheduling:
   1. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.07 SUBMITTALS

A. Utility Company letter of availability for providing electrical service to project.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product. Include ratings, configurations, standard wiring diagrams, outline and support point dimensions, finishes, weights, service condition requirements, and installed features.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations and arrangement of Utility Company and service entrance equipment, metering provisions, required clearances, and proposed service routing.

D. Project Record Documents: Record actual locations of equipment and installed service routing.

1.08 QUALITY ASSURANCE

A. Comply with the following:
   1. IEEE C2 (National Electrical Safety Code).
   2. NFPA 70 (National Electrical Code).
   3. The requirements of the Utility Company.
   4. The requirements of the local authorities having jurisdiction.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor rated products which are not weatherproof until completely and properly installed). Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle products carefully to avoid damage to internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 ELECTRICAL SERVICE REQUIREMENTS

A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.

B. Electrical Service Characteristics: As indicated on drawings.

C. Utility Company: As indicated on drawings.

D. Division of Responsibility: As indicated on drawings.

E. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Verify and mark locations of existing underground utilities.

3.03 INSTALLATION

A. Install products in accordance with manufacturer's instructions and Utility Company requirements.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Provide required trenching and backfilling in accordance with Division 31.

E. Construct cast-in-place concrete pads for utility equipment in accordance with Utility Company requirements and Section 03 3000.

F. Provide required protective bollards in accordance with Utility Company requirements.

G. Provide required support and attachment components in accordance with Section 26 0529.

H. Provide grounding and bonding for service entrance equipment in accordance with Section 26 0526.

I. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 26 0553.

3.04 PROTECTION

A. Protect installed equipment from subsequent construction operations.

END OF SECTION

SECTION 26 2200
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. General purpose transformers.

1.03 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0529 - Hangers and Supports for Electrical Systems.

D. Section 26 0533.13 - Conduit for Electrical Systems: Flexible conduit connections.

E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.04 REFERENCE STANDARDS

A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers.

B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers.

C. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction.

E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers.

F. NEMA ST 20 - Dry-Type Transformers for General Applications.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

I. NFPA 70 - National Electrical Code.

J. UL 506 - Standard for Specialty Transformers.

K. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with placement of supports, anchors, etc. required for mounting.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.06 SUBMITTALS

A. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.

B. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.

C. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.

D. Field Quality Control Test Reports.

E. Maintenance Data: Include recommended maintenance procedures and intervals.

F. Project Record Documents: Record actual locations of transformers.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.09 FIELD CONDITIONS

A. Ambient Temperature: Do not exceed the following maximum temperatures during and after installation of transformers.
   1. Greater than 10 kVA: 104 degrees F maximum.
   2. Less than 10 kVA: 77 degrees F maximum.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com/#sle.
   1. Or approved equal.

B. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
   1. Altitude: Less than 3,300 feet.
   2. Ambient Temperature:
      a. Greater than 10 kVA: Not exceeding 104 degrees F.
      b. Less than 10 kVA: Not exceeding 77 degrees F.

C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

E. Basic Impulse Level: 10 kV.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.03 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Insulation System and Allowable Average Winding Temperature Rise:
   1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
   2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

C. Coil Conductors: Continuous copper windings with terminations brazed or welded.

D. Winding Taps:
   1. Less than 3 kVA: None.
   2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
   3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
   4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.

E. Energy Efficiency: Comply with 10 CFR 431, Subpart K.

F. Sound Levels: Standard sound levels complying with NEMA ST 20

G. Mounting Provisions:
   1. Less than 15 kVA: Suitable for wall mounting.
   2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
   3. Larger than 75 kVA: Suitable for floor mounting.

H. Transformer Enclosure: Comply with NEMA ST 20.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor clean, dry locations: Type 2.
      b. Outdoor locations: Type 3R.
   2. Construction: Steel.
      a. Less than 15 kVA: Totally enclosed, non-ventilated.
      b. 15 kVA and Larger: Ventilated.
   3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
   4. Provide lifting eyes or brackets.

I. Accessories:
   1. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.04 SOURCE QUALITY CONTROL

A. Factory test transformers according to NEMA ST 20.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install transformers in accordance with NECA 409 and IEEE C57.94.

D. Use flexible conduit, under the provisions of Section 26 0533.13, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.

F. Install transformers plumb and level.

G. Transformer Support:
   1. Provide required support and attachment in accordance with Section 26 0529, where not furnished by transformer manufacturer.
   2. Use field-fabricated supports to support wall-mounted transformers.
   3. Unless otherwise indicated, mount floor-mounted transformers on properly sized 4 inch high concrete pad constructed in accordance with Section 03 3000.
   4. Use trapeze hangers assembled from threaded rods and metal channel (strut) to support suspended transformers. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

H. Provide grounding and bonding in accordance with Section 26 0526.

I. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

J. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.

K. Identify transformers in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.

3.04 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from transformer components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 2413
SWITCHBOARDS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.

B. Overcurrent protective devices for switchboards.

1.03 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0529 - Hangers and Supports for Electrical Systems.

D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 0573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

F. Section 26 2100 - Low-Voltage Electrical Service Entrance.

G. Section 26 4300 - Surge Protective Devices.

1.04 REFERENCE STANDARDS

A. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction.

C. NECA 400 - Standard for Installing and Maintaining Switchboards.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NEMA PB 2 - Deadfront Distribution Switchboards.

F. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.

G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

H. NFPA 70 - National Electrical Code.

I. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.

J. UL 869A - Reference Standard for Service Equipment.

K. UL 891 - Switchboards.

L. UL 1053 - Ground-Fault Sensing and Relaying Equipment.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Service Entrance Switchboards:
1. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
2. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.

B. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of switchboards and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.

C. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 2 as production (routine) tests.

D. Field Quality Control Test Reports.

E. Project Record Documents: Record actual installed locations of switchboards and final equipment settings.

F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.09 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switchboards:
1. Eaton Corporation: www.eaton.com/#sle.

a. Or approved equal.

B. Source Limitations: Furnish switchboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 SWITCHBOARDS

A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.

D. Front-Connected Switchboards:
1. Main Device(s): Individually-mounted.
2. Feeder Devices: Panel/group-mounted.
3. Arrangement: Front accessible only (not rear accessible), rear aligned.
4. Gutter Access: Bolted covers.

E. Service Entrance Switchboards:
1. Listed and labeled as suitable for use as service equipment according to UL 869A.
2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.
3. Comply with Utility Company requirements for electrical service.

F. Service Conditions:
1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:
   a. Altitude: Less than 6,600 feet.
   b. Ambient Temperature:
      1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F and 104 degrees F.
2. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

G. Short Circuit Current Rating:
1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.

H. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

I. Bussing: Sized in accordance with UL 891 temperature rise requirements.
1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
2. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
3. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
4. Phase and Neutral Bus Material: Copper.
5. Ground Bus Material: Copper.

J. Conductor Terminations: Suitable for use with the conductors to be installed.

1. Line Conductor Terminations:
    a. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
    b. Main and Neutral Lug Type: Mechanical.
2. Load Conductor Terminations:
    a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
    b. Lug Type:
        1) Provide mechanical lugs unless otherwise indicated.

K. Enclosures:
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
    a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).
2. Finish: Manufacturer's standard unless otherwise indicated.

L. Future Provisions:
1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

M. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 4300, list switchboards as a complete assembly including surge protective device.

N. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
    a. Use zero sequence or residual ground fault detection method unless otherwise indicated.
    b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

O. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

P. Owner Metering:
1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.
2. Measured Parameters:
    a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
    b. Current (Amps): For each phase and neutral.
    c. Frequency (Hz).
    d. Real power (kW): For each phase, 3-phase total.
    e. Reactive power (kVAR): For each phase, 3-phase total.
    f. Apparent power (kVA): For each phase, 3-phase total.
    g. Power factor.
3. Meter Accuracy: Plus/minus 1.0 percent.

Q. Instrument Transformers:
1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Connect secondaries to shorting terminal blocks.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:
   1. Interrupting Capacity:
      a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
      b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   2. Molded Case Circuit Breakers:
      a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.
         1) Provide thermal magnetic circuit breakers unless otherwise indicated.
         2) Provide electronic trip circuit breakers where indicated.
      b. Minimum Interrupting Capacity:
         1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
         2) 14,000 rms symmetrical amperes at 480 VAC.
      c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
         1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
      d. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
         1) Provide the following field-adjustable trip response settings:
            (a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
            (b) Long time delay.
            (c) Short time pickup and delay.
            (d) Instantaneous pickup.
            (e) Ground fault pickup and delay where ground fault protection is indicated.
      e. Provide the following circuit breaker types where indicated:
         1) 100 Percent Rated Circuit Breakers: Listed for application within the switchboard where installed at 100 percent of the continuous current rating.
      f. Provide the following features and accessories where indicated or where required to complete installation:
         1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
         2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.

2.04 SOURCE QUALITY CONTROL

A. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard assembly or component:
   1. Dielectric tests.
   2. Mechanical operation tests.
   3. Grounding of instrument transformer cases test.
   4. Electrical operation and control wiring tests, including polarity and sequence tests.
   5. Ground-fault sensing equipment test.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive switchboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.

D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.

E. Provide required support and attachment in accordance with Section 26 0529.

F. Install switchboards plumb and level.

G. Unless otherwise indicated, mount switchboards on properly sized 4 inch high concrete pad constructed in accordance with Section 03 3000.

H. Provide grounding and bonding in accordance with Section 26 0526.

I. Install all field-installed devices, components, and accessories.

J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

K. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 0573.

L. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

M. Provide filler plates to cover unused spaces in switchboards.

N. Identify switchboards in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

B. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Perform inspections and tests listed in NETA ATS, Section 7.1.

E. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.

F. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
   1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

G. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

H. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.

I. Test shunt trips to verify proper operation.

J. Correct deficiencies and replace damaged or defective switchboards or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of switchboard covers and doors.

3.05 CLEANING

A. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation, adjustment, and maintenance of switchboard and associated devices.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.07 PROTECTION

A. Protect installed switchboards from subsequent construction operations.

END OF SECTION

SECTION 26 2416
PANELBOARDS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Power distribution panelboards.

B. Lighting and appliance panelboards.

C. Overcurrent protective devices for panelboards.

1.03 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0529 - Hangers and Supports for Electrical Systems.

D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 0573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

F. Section 26 4300 - Surge Protective Devices.

1.04 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.

B. NECA 407 - Standard for Installing and Maintaining Panelboards.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. NEMA PB 1 - Panelboards.

E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

F. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

G. NFPA 70 - National Electrical Code.

H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.

I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.

J. UL 67 - Panelboards.

K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.

L. UL 943 - Ground-Fault Circuit-Interrupters.

M. UL 1053 - Ground-Fault Sensing and Relaying Equipment.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.

C. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 1 as routine tests.

D. Field Quality Control Test Reports.

E. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.09 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:
1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com/#sle.
1. Or approved equal.

B. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

C. Short Circuit Current Rating:
   1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.

D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
   1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
   2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

G. Conductor Terminations: Suitable for use with the conductors to be installed.

H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Boxes: Galvanized steel unless otherwise indicated.
      a. Provide wiring gutters sized to accommodate the conductors to be installed.
      b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
   3. Fronts:
      a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
      b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
   4. Lockable Doors: All locks keyed alike unless otherwise indicated.

I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

J. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 4300, list and label panelboards as a complete assembly including surge protective device.

K. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
   1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
   2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
      a. Use zero sequence ground fault detection method unless otherwise indicated.
      b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

L. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

M. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

N. Provide the following features and accessories where indicated or where required to complete installation:
   1. Feed-through lugs.
   2. Sub-feed lugs.

2.03 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
   1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
   1. Phase and Neutral Bus Material: Copper.
   2. Ground Bus Material: Copper.

D. Circuit Breakers:
   1. Provide bolt-on type.
   2. Provide thermal magnetic circuit breakers unless otherwise indicated.
   3. Provide electronic trip circuit breakers where indicated.

E. Enclosures:
   1. Provide surface-mounted enclosures unless otherwise indicated.
   2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
   3. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
   1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
   1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
   2. Phase and Neutral Bus Material: Copper.
   3. Ground Bus Material: Copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:
   1. Provide surface-mounted or flush-mounted enclosures as indicated.

2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.05 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
      2) 14,000 rms symmetrical amperes at 480 VAC.
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
3. Conductor Terminations:
   a. Provide mechanical lugs unless otherwise indicated.
   b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
   a. Provide the following field-adjustable trip response settings:
      1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
      2) Long time delay.
      3) Short time pickup and delay.
      4) Instantaneous pickup.
      5) Ground fault pickup and delay where ground fault protection is indicated.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:
   a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
   b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
   c. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.
8. Do not use tandem circuit breakers.
9. Do not use handle ties in lieu of multi-pole circuit breakers.
10. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
11. Provide the following features and accessories where indicated or where required to complete installation:
    a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
    b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

2.06 SOURCE QUALITY CONTROL

A. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required support and attachment in accordance with Section 26 0529.

F. Install panelboards plumb.

G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

I. Mount floor-mounted power distribution panelboards on properly sized 4 inch high concrete pad constructed in accordance with Section 03 3000.

J. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

K. Provide grounding and bonding in accordance with Section 26 0526.
   1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.

L. Install all field-installed branch devices, components, and accessories.

M. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.

N. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 0573.

O. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

P. Provide filler plates to cover unused spaces in panelboards.

Q. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
   1. Emergency and night lighting circuits.
   2. Fire detection and alarm circuits.
   3. Communications equipment circuits.
   4. Intrusion detection and access control system circuits.
   5. Video surveillance system circuits.

R. Identify panelboards in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.

C. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

D. Test GFCI circuit breakers to verify proper operation.

E. Test shunt trips to verify proper operation.

F. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 2726
WIRING DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Wall switches.

B. Receptacles.

C. Wall plates.

D. Poke-through assemblies.

1.03 RELATED REQUIREMENTS

A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0533.16 - Boxes for Electrical Systems.

D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 0583 - Wiring Connections: Cords and plugs for equipment.

F. Section 26 0923 - Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors.

G. Section 27 1000 - Structured Cabling: Voice and data jacks.

1.04 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.

C. NEMA WD 1 - General Color Requirements for Wiring Devices.

D. NEMA WD 6 - Wiring Devices - Dimensional Specifications.

E. NFPA 70 - National Electrical Code.

F. UL 20 - General-Use Snap Switches.

G. UL 498 - Attachment Plugs and Receptacles.

H. UL 514D - Cover Plates for Flush-Mounted Wiring Devices.

I. UL 943 - Ground-Fault Circuit-Interrupters.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
4. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.

5. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Sequencing:
   1. Do not install wiring devices until final surface finishes and painting are complete.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

B. Field Quality Control Test Reports.

C. Operation and Maintenance Data:
   1. GFCI Receptacles: Include information on status indicators.

D. Project Record Documents: Record actual installed locations of wiring devices.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.08 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.

C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.

D. Provide GFCI protection for receptacles installed within 6 feet of sinks.

E. Provide GFCI protection for receptacles installed in kitchens.

F. Provide GFCI protection for receptacles serving electric drinking fountains.

2.02 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.

B. Wiring Devices, Unless Otherwise Indicated: White with stainless steel wall plate.

C. Wiring Devices Connected to Emergency Power: Red with stainless steel wall plate factory engraved "Emergency".

2.03 WALL SWITCHES

A. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

B. Standard Wall Switches: Commercial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw or three way as indicated on the drawings.

2.04 RECEPTACLES

A. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
   2. NEMA configurations specified are according to NEMA WD 6.

B. Convenience Receptacles:
   1. Standard Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
   2. Automatically Controlled Convenience Receptacles connected to LCP: Commercial specification grade, 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per NFPA 70; single or duplex as indicated on the drawings.
   3. Tamper Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.

C. GFCI Receptacles:
   1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
      a. Provide test and reset buttons of same color as device.
   2. Standard GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
   3. Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
   4. Tamper Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.

2.05 WALL PLATES

A. Wall Plates: Comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   2. Size: Standard.
   3. Screws: Metal with slotted heads finished to match wall plate finish.

B. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

C. Weatherproof Covers for Wet or Damp Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

D. Where indicated, provide security faceplates in accordance with the following:
   1. Faceplate shall be one-piece heavy gauge prime grade material (14ga. CRS, painted)
   2. Die formed with four countersunk holes for Torx security fasteners.
   3. Backplate shall be prime grade 11-ga galvanized steel.
   4. Acceptable manufacturers:
      a. Kenall Mighty Mac Series
      b. Or Approved Equal

2.06 POKE-THROUGH ASSEMBLIES

A. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.

B. Flush Floor Service Fittings:
   1. Dual Service Flush Combination Outlets:
      a. Cover: Hinged door(s).
      b. Configuration:
         1) Power: Two standard convenience duplex receptacle(s).
         2) Voice and Data Jacks: As specified in Section 27 1000.
   2. Accessories:
      a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

F. Verify that core drilled holes for poke-through assemblies are in proper locations.

G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of wiring devices provided under this section.
   1. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
   2. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
   3. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.

C. Install wiring devices in accordance with manufacturer's instructions.

D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

I. Install wiring devices plumb and level with mounting yoke held rigidly in place.

J. Install wall switches with OFF position down.

K. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

L. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

M. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

N. Identify wiring devices in accordance with Section 26 0553.

O. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

3.04 FIELD QUALITY CONTROL

A. Inspect each wiring device for damage and defects.

B. Operate each wall switch and wall dimmer with circuit energized to verify proper operation.

C. Test each receptacle to verify operation and proper polarity.

D. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

E. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 2726.13
WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SUMMARY

A. Section Includes the following for site electrical work:

1. Receptacles, receptacles with integral GFCI, and associated device plates.

2. Weather–resistant receptacles.

3. Snap Switches.

4. Cord and plug sets.

1.03 DEFINIITIONS

A. GFCI: Ground-fault circuit interrupter.

B. Pigtail: Short lead used to connect a device to a branch circuit conductor.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Match plug configurations for existing equipment or equipment furnished by others.

1.05 ACTION SUBMITTALS

A. Product data for each type of product.

1.06 INFORMATIONAL SUBMITTALS

A. Field quality control reports.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturer's packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1. Eaton (Arrow Hart).

2. Hubbell Incorporated; Wiring Device-Kellems.

3. Leviton Manufacturing Co., Inc.

4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 GENERAL WIRING-DEVICE REQUIREMENTS

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

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.

2. Devices shall comply with the requirements in this Section.

2.03 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

2.04 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type.

1. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.

2. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection. Provide 20 Amp rated device unless otherwise noted.

2.05 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.

1. Subject to compliance with requirements, provide products by one of the following:
   a. Eaton (Arrow Hart).
   b. EGS/Appleton Electric.
   c. Killark.

2.06 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.07 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Single Pole:
      1) Cooper; AH1221.
      2) Hubbell; HBL1221.
      3) Leviton; 1221-2.
      4) Pass & Seymour; CSB20AC1.

2.08 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Unfinished Spaces: Galvanized steel.

3. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather resistant, extra-duty, in-use, die-cast aluminum with lockable cover.

2.09 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: Ivory unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.02 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.03 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.

2. Ground Impedance: Values of up to 2 ohms are acceptable.

3. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

4. Using the test plug, verify that the device and its outlet box are securely mounted.

5. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

END OF SECTION

SECTION 26 2813
FUSES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Fuses.

1.03 RELATED REQUIREMENTS

A. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

B. Section 26 0573 - Power System Studies: Additional criteria for the selection of protective devices specified in this section.

C. Section 26 2816.16 - Enclosed Switches: Fusible switches.

D. Section 26 2913 - Enclosed Controllers: Fusible switches.

1.04 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses.

B. NFPA 70 - National Electrical Code.

C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements.

D. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses.

E. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
      a. Fusible Enclosed Switches: See Section 26 2816.16.
      b. Fusible Switches for Enclosed Motor Controllers: See Section 26 2913.
   2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
   3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. Service Entrance:
   1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
   2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.

B. Feeders:
   1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.

2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.

C. General Purpose Branch Circuits: Class RK1, time-delay.

D. Individual Motor Branch Circuits: Class RK1, time-delay.

2.02 FUSES

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. Class R Fuses: Comply with UL 248-12.

H. Class L Fuses: Comply with UL 248-10.

I. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

J. Provide the following accessories where indicated or where required to complete installation:
   1. Fuseholders: Compatible with indicated fuses.
   2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION

SECTION 26 2816.16
ENCLOSED SWITCHES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Enclosed safety switches.

1.03 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 0573 - Power System Studies: Additional criteria for the selection of equipment and associated protective devices specified in this section.

E. Section 26 2813 - Fuses.

F. Section 26 2913 - Enclosed Controllers: Manual motor controllers.

1.04 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

E. NFPA 70 - National Electrical Code.

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.

H. UL 98 - Enclosed and Dead-Front Switches.

I. UL 869A - Reference Standard for Service Equipment.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

B. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.
   2. Include wiring diagrams showing all factory and field connections.

C. Field Quality Control Test Reports.

D. Project Record Documents: Record actual locations of enclosed switches.

E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.09 FIELD CONDITIONS

A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com/#sle.
   1. Or approved equal.

B. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature: Between -22 degrees F and 104 degrees F.

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating:
   1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.

G. Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

H. Provide with switch blade contact position that is visible when the cover is open.

I. Fuse Clips for Fusible Switches: As required to accept fuses indicated.

J. Conductor Terminations: Suitable for use with the conductors to be installed.

K. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

L. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

M. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.

N. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

O. Heavy Duty Switches:
   1. Comply with NEMA KS 1.
   2. Conductor Terminations:
      a. Provide mechanical lugs unless otherwise indicated.
      b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
      a. Provide means for locking handle in the ON position where indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed safety switches.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment in accordance with Section 26 0529.

E. Install enclosed switches plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

G. Provide grounding and bonding in accordance with Section 26 0526.

H. Provide fuses complying with Section 26 2813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.

I. Identify enclosed switches in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

C. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 2817
MOLDED CASE CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SUMMARY

A. Section includes:

1. Molded-case circuit breakers (MCCBs) replacements in existing power panels.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of circuit breaker, accessory, and component indicated. Include manufacturers' technical data on features, performance, electrical characteristics, ratings, and accessories.

1. Current and voltage ratings.

2. Short-circuit current ratings (interrupting and withstand, as appropriate).

3. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

1.04 INFORMATIONAL SUBMITTALS:

A. Field quality-control reports.

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.05 CLOSEOUT SUBMITTALS:

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to other items to be included in the "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.06 QUALITY ASSURANCE:

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

D. Comply with NFPA 70.

1.07 PRODUCT CONDITIONS:

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F. and not exceeding 104 deg F.

2. Altitude: Not exceeding 6600 feet.

B. 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 weeks in advance of proposed interruption of electric service.

2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Engineer/Owner's written permission.

4. Comply with NFPA 70E.

1.08 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.01 MOLDED-CASE CIRCUIT BREAKERS

A. Subject to compliance with requirements, provide a circuit breaker made by the same manufacturer as the panelboard where circuit breaker is to be installed.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents of the existing circuit breakers within the power panels. Number of poles, voltage and ampere rating shall be as shown on the drawings.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

D. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.02 INSTALLATION

A. Circuit breakers installed in existing panels shall be installed in accordance with manufacturer's recommendations.

B. Comply with NECA 1.

3.03 IDENTIFICATION

A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

   Create new panelboard directory for each existing panelboard that had circuit breakers replaced and/or added.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each circuit breaker, 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. Perform the following infrared scan tests and inspections and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

   b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

SECTION 26 2913
ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
   1. Magnetic motor starters.
   2. Manual motor starters.
   3. Motor-starting switches without overload protection.

B. Overcurrent protective devices for motor controllers, including overload relays.

1.03 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 0573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

E. Section 26 2813 - Fuses: Fuses for fusible switches.

1.04 REFERENCE STANDARDS

A. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.

E. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.

F. NEMA ICS 6 - Industrial Control and Systems: Enclosures.

G. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

I. NFPA 70 - National Electrical Code.

J. UL 98 - Enclosed and Dead-Front Switches.

K. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules.

L. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.

3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
6. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.

B. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of enclosed controllers and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.

C. Field Quality Control Test Reports.

D. Project Record Documents: Record actual installed locations of controllers and final equipment settings.

E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.09 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com/#sle.
1. Or approved equal.

B. Source Limitations: Furnish enclosed motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.
1. Motor-starting switches without overload protection may be produced by the same manufacturer as the wiring devices used for this project.

2.02 ENCLOSED CONTROLLERS

A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.

D. Service Conditions:
   1. Provide controllers and associated components suitable for operation under the following service conditions without derating:
      a. Altitude:
         1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet.
         2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet.
      b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
   2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

E. Short Circuit Current Rating:
   1. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.

F. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

G. Conductor Terminations: Suitable for use with the conductors to be installed.

H. Enclosures:
   1. Comply with NEMA ICS 6.
   2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1 or Type 12.
      b. Outdoor Locations: Type 3R or Type 4.
   3. Finish: Manufacturer's standard unless otherwise indicated.

I. Instrument Transformers:
   1. Comply with IEEE C57.13.
   2. Select suitable ratio, burden, and accuracy as required for connected devices.
   3. Current Transformers: Connect secondaries to shorting terminal blocks.
   4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

J. Magnetic Motor Starters: Combination type unless otherwise indicated.
   1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
   2. Configuration: Full-voltage non-reversing unless otherwise indicated.
   3. Minimum Starter Size: NEMA Size 0.
   4. Disconnects: Disconnect switch type.
      a. Disconnect Switches: Fusible type unless otherwise indicated.
      b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
      c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
   5. Overload Relays: Bimetallic thermal type unless otherwise indicated.
   6. Pilot Devices Required:

a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings.
b. Single-Speed, Non-Reversing Starters:
1) Pushbuttons: START-STOP.
2) Selector Switches: HAND/OFF/AUTO.
3) Indicating Lights: Red ON, Green OFF.

K. Manual Motor Starters:
1. Description: NEMA ICS 2, Class A manually-operated motor controllers with overload relay(s).
2. Configuration: Non-reversing unless otherwise indicated.
3. Fractional-Horsepower Manual Motor Starters:
a. Furnish with toggle operator.
b. Overload Relays: Bimetallic or melting alloy thermal type.
c. Provide means for locking operator in the OFF position.
d. Furnish Red ON indicating light where not within sight of equipment.
4. Integral-Horsepower Manual Motor Starters:
a. Furnish with toggle or pushbutton operator.
b. Overload Relays: Bimetallic or melting alloy thermal type.
c. Provide means for locking operator in the OFF position.
d. Furnish Red ON indicating light where not within sight of equipment.

L. Motor-Starting Switches: Horsepower-rated switches without overload protection; toggle operator.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:
1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
3. Trip-free operation.
4. Visible trip indication.
5. Resettable.
a. Employ manual reset unless otherwise indicated.
b. Do not employ automatic reset with two-wire control.
6. Bimetallic Thermal Overload Relays:
a. Interchangeable current elements/heaters.
b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
c. Trip test function.
7. Melting Alloy Thermal Overload Relays:
a. Interchangeable current elements/heaters.

B. Fusible Disconnect Switches:
1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
2. Fuse Clips: As required to accept indicated fuses.
3. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

2.04 CONTROL ACCESSORIES

A. Auxiliary Contacts:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:
   1. Comply with NEMA ICS 5; heavy-duty type.
   2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
   3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
   4. Indicating Lights: Push-to-test type unless otherwise indicated.
   5. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of relays indicated or required to perform necessary functions.

D. Control Power Transformers:
   1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus 25% VA spare capacity.
   2. Include primary and secondary fuses.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of enclosed controllers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install controllers in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment in accordance with Section 26 0529.

E. Install enclosed controllers plumb and level.

F. Provide grounding and bonding in accordance with Section 26 0526.

G. Install all field-installed devices, components, and accessories.

H. Provide fuses complying with Section 26 2813 for fusible switches as indicated.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.

K. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 0573.

L. Identify enclosed controllers in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.

C. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

D. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.

B. Training: Train Owner's personnel on operation, adjustment, and maintenance of enclosed controllers and associated devices.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.07 PROTECTION

A. Protect installed enclosed controllers from subsequent construction operations.

END OF SECTION

SECTION 26 3213
ENGINE GENERATORS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SCOPE

A. Provide one new complete factory assembled generator set equipped with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator.

B. Provide new digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator for an existing generator. These controls shall be identical to and compatible with those provided with the new generator.

C. Provide factory test, startup by a supplier authorized by the equipment manufacturer(s), and on-site testing of the system.

D. The generator set manufacturer shall warrant all equipment provided under this section, whether or not it is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

1.03 CODES AND STANDARDS

A. The generator set installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable. The generator set shall include necessary features to meet the requirements of these standards.
   1. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
   2. NFPA37 – Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
   3. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 517, 700, 701, and 702.
   4. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.

B. The generator set and supplied accessories shall meet the requirements of the following standards:
   1. NEMA MG1. Alternator shall comply with the requirements of the current version this standard as they apply to AC alternators.
   2. UL142 – Sub-base Tanks
   3. UL1236 – Battery Chargers
   4. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.

C. The control system for the generator set shall comply with the following requirements.
   1. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
   2. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
   3. FCC Part 15, Subpart B.

4. IEC8528 part 4. Control Systems for Generator Sets
5. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
6. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
7. UL1236 –Battery Chargers
8. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

D. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.04 SUBMITTALS

A. After award of contract, provide six sets of the following information for review:
1. Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
2. A paragraph by paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
3. Manufacturer's certification of prototype testing.
4. Manufacturer's published warranty documents.
5. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
6. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
7. Manufacturer's installation instructions.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Only approved bidders shall supply equipment provided under this contract. Equipment specifications for this project are based on a Cummins Model 900 DQFAC generator set manufactured by Cummins Power Generation with microprocessor-based controls.

B. Other Acceptable Manufacturers: Caterpillar and Kohler.

2.02 GENERATOR SET

A. Ratings
1. The generator set shall operate at 1800 rpm and at a voltage of: 277/480 Volts AC, Three phase, 4-wire, 60 hertz.
2. The generator set shall be rated at 900 kW, 1125 kVA at 0.8 PF, standby rating, based on site conditions of: Altitude 1200ft., ambient temperatures up to 122 degrees F (50 degrees C).
3. The generator set rating shall be based on stationary emergency standby service.

B. Performance
1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5%.
3. The diesel engine-generator set shall accept a single step load of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

4. Motor starting capability shall be a minimum of 4602 kVA. The generator set shall be capable of recovering to a minimum of 90% of rated no load voltage following the application of the specified kVA load at near zero power factor applied to the generator set. Starting kVA measured at a percent of voltage drop is not acceptable. The engine and alternator combination shall provide a starting kW of 920 skW. If a particular manufacturers generator set does not meet these requirements, a larger generator set must be provided.
5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no 3rd order harmonics or their multiples. Telephone influence factor shall be less than 40.
6. The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning. The generator set shall be EPA Certified Tier 2.

C. Construction
1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. All active control components shall be installed within a UL/NEMA 3R enclosure. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

D. Connections
1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
3. Generator set control interfaces to other system components shall be made on a permanently labeled terminal block assembly. Labels describing connection point functions shall be provided.

2.03 ENGINE AND ENGINE EQUIPMENT

A. The engine shall be diesel, 4 cycle, 12 cylinders, radiator and fan cooled. Minimum displacement shall be 1860 cubic inches. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories, but not less than 1490 bhp. Two cycle engines are not acceptable.

B. Engine accessories and features shall include:
1. An electronic governor system shall provide automatic isochronous frequency regulation. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed. The governing system shall include a programmable warm up at idle and cooldown at idle function. While operating in idle state, the control system shall disable the alternator excitation system.
2. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the alternator air inlet. Radiator fan shall be suitable for use in a system with 0.5 in H2O restriction. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled

environment. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture prior to shipping. Rotating parts shall be guarded against accidental contact.

3. Electric starter(s) capable of three complete cranking cycles without overheating.
4. Positive displacement, mechanical, full pressure, lubrication oil pump.
5. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
6. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
7. Replaceable dry element air cleaner with restriction indicator.
8. Flexible supply and return fuel lines.
9. Engine mounted battery charging alternator, 35-ampere minimum, and solid-state voltage regulator.
10. Coolant heater
    a. Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.
    b. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall include provisions to isolate the heater for replacement of the heater element without draining the coolant from the generator set. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
    c. The coolant heater shall be provided with a DC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
    d. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104F (40C) in a 40F (4C) ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.
11. Provide vibration isolators between the engine, alternator, and structural steel base. The generator assembly shall be seismic certified listed and labeled to IBC 2000, 2003, 2006 requirements. Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three complete 15-second cranking cycles at 40F ambient temperature when fully charged.
12. Provide a 12 amp minimum battery charger for each generator set battery bank. Generator sets incorporating two battery banks shall be provided with two chargers connected together and operating in parallel, with alarm output(s) connected in parallel. The charger(s) shall include the following capabilities:
    a. Chargers shall be UL 1236-BBHH listed and certified for use in emergency applications.
    b. The charger shall be compliant with UL991 requirements for vibration resistance.
    c. The charger shall comply with the requirements of EN61000-4-5 for voltage surge resistance; EN50082-2 for immunity; EN61000-4-2 for ESD; EN61000-4-3 for radiated immunity; ANSI/IEEE C62.41 category B and IN61000-4-4 for electrically fast transient; EN61000-4-6 for conducted emissions; and FCC Part 15 Class A for radiated emissions.

d. The charger shall be capable of charging a fully discharged battery without damage to the charger. It shall be capable of returning a fully discharged battery to fully charged condition within 24 hours. The charger shall be UL-labeled with the maximum battery amp-hour rating that can be recharged within 24 hours. The label shall indicate that the charger is suitable for charging of 200AH batteries per NFPA requirements.
e. The charger shall incorporate a 4-state charging algorithm, to provide trickle charge rate to restore fully discharged batteries, a bulk charge rate to provide fastest possible recharge after normal discharge, an absorption state to return the battery to 100 percent of charge, and a float stage to maintain a fully charge battery and supply battery loads when the generator set is not operating. In addition, the charger shall include an equalization timer. Charge rates shall be temperature compensated based on the temperature directly sensed at the battery.
f. The DC output voltage regulation shall be within plus or minus 1%. The DC output ripple current shall not exceed 1 amp at rated output current level.
g. The charger shall include the following features:
    1) two line alphanumeric display with programming keys to allow display of DC output ammeter and voltmeters (5% accuracy or better), display alarm messages, and perform programming;
    2) LED indicating lamp(s) to indicating normal charging condition (green), equalize charge state (amber), and fault condition (red);
    3) AC input overcurrent, over voltage, and undervoltage protection;
    4) DC output overcurrent protection;
    5) Alarm output relay
    6) Corrosion resistant aluminum enclosure

2.04 AC GENERATOR

A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system and shall be UL1446 listed. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees Centigrade with a starting kVA of 3313 skVA. The alternator/engine combination shall provide a minimum of 820 skW (starting or surge kW).

B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.

D. The subtransient reactance of the alternator shall not exceed 14 percent, based on the standby rating of the generator set.

2.05 GENERATOR SET CONTROL.

A. Provide a microprocessor-based generator set monitoring, metering, protection and control system mounted on the generator set. Control shall be Cummins Power Generation PCC 3.3 Control with paralleling.

B. Operator Panel
    1. Each microprocessor-based generator set monitoring, metering, protection and control system shall be provided with a panel to allow the operator to view the status and control operation of the specific generator set being paralleled. The operator panel shall be provided with the following features and capabilities:

a. A graphical display capable of displaying up to 9 lines of data with approximately 27 characters per line.
    1) Include a set of six tactile feel membrane switches that are used by the operator to navigate through control menus, and to make control adjustments.
    2) Incorporate three levels of operation and adjustability. All data on the control panel can be viewed by scrolling through screens with the navigation keys.
    3) Top three lines of the display shall be allocated to mode and status messages that continuously display the operating mode of the control system, as well as any faults or warning conditions that may be present on the controller.
    4) If more than one fault or warning message is present the messages will scroll to allow the operator to view all active messages in the system.
b. Analog AC metering panel
    1) Simultaneously display 3-phase line to line AC volts and current, kW, power factor, and frequency.
    2) Meter panel is composed of a series of LED's configured in bar graphs for each function. LED's to be color coded, with green indicating normal range values, amber for warning levels, and red for shutdown conditions.
    3) Scales for each function are in % of nominal rated values.
c. OFF/MANUAL/AUTO Mode Control Switch
    1) NOT IN AUTO lamp will flash when the control is in the MANUAL or OFF mode.
    2) In AUTO mode, the generator set can be started using the exercise push-button, or with a start signal from a remote device, such as automatic transfer switches.
d. MANUAL RUN/STOP Control Switch and Indicating LED
    1) When mode control switch is in MANUAL position and MANUAL RUN/STOP switch is pressed, Generator set will start, bypassing all time delays for idle mode or time delay start.
    2) If generator set is running in MANUAL mode, pressing RUN/STOP switch will cause generator set to shut down.
    3) An LED (light emitting diode) lamp adjacent to switch will light to indicate generator set is in manual mode.
e. EXERCISE Control Switch and Indicating LED
    1) When mode control switch is in AUTO mode EXERCISE control switch is used to complete a pre-programmed exercise sequence.
    2) All exercise functions are disabled when an emergency start command is received by control. An LED lamp adjacent to switch will light to indicate generator set is in exercise mode.
f. Operator Adjustments
    1) Control shall include provisions for manual set up and adjustment functions via raise/lower switches on operator panel. Following functions shall be adjustable by the operator:
        (a) Time delay start (0-300 seconds)
        (b) Time delay stop (0-600 seconds)
        (c) Alternator voltage (plus or minus 5%)
        (d) Alternator frequency (plus or minus 3 hertz).
        (e) Voltage and frequency adjustments shall be disabled during operation in parallel with a system bus to prevent inadvertent misadjustment of the paralleling load sharing functions.
        (f) Emergency Stop Control Switch
        (g) Panel Lamp/Lamp Test Control Switch
    2) AC Metering
        (a) Each microprocessor-based generator set monitoring, metering, protection and control system shall display the following AC metering data. Meter

data shall also be displayed on the screen of the master control:

(1) Load Profile Data - Provide data indicating operating hours at percent of load, in 10% increments. Data shall be presented based on total operating hours on generator set, and also on loads on the generator set.
(2) Generator Set Output Voltage – Shall display all phases, line to line and line to neutral, accuracy 1%.
(3) Generator Set Output Current – Shall display all phases, accuracy 1%.
(4) Generator Set Output Frequency
(5) Generator Set Power Output – Shall display generator set kW and kVA output (average and individual phase, and direction of flow), and power factor with leading/lagging indication, accuracy 5%.
(6) Generator Set kWh Power Output – Shall display total kilowatt-hours produced by the generator set, and total produced since last reset, with time stamp of time of last reset.
(7) Running Time Meter, Start Counter

3) Engine Control
   (a) Engine Starting
      (1) Control shall operate a factory-supplied fuel valve that enables engine starting.
   (b) Cycle Cranking
      (1) Control shall be configurable for number of starting cycles (1 to 7) and duration of crank and rest periods.
      (2) Control shall include starter protection algorithms to prevent operator from specifying a starting sequence that might be damaging. Default setting shall be for (3) start cycles composed of 15 seconds of cranking, and 15 seconds of rest.
   (c) Programmable Idle Speed Control
      (1) In this mode generator set would start and run to idle speed. It would operate at that speed for a programmed time period, then ramp to rated speed. When the control gets a signal to stop, it will ramp to idle, operate for the programmed period at idle, and then shut down.
      (2) During idle mode engine protective functions are adjusted for the lower engine speed, and alternator function is disabled.
   (d) Time Delay Start And Stop (cool-down)
      (1) Control shall be configurable for time delay of 0-300 seconds prior to starting after receiving a remote start signal, and for time delay of 0-600 seconds prior to ramp to idle or shut down after signal to stop in normal operation modes.
      (2) Generator set control shall monitor load during operation of generator set, and if total load on the set is less than 10% of rated, it shall reduce operation time for time delay stop to prevent extended operation of the engine at very light load levels.
      (3) The default for both time delay periods shall be 0 seconds.
4) Alternator Control
   (a) Digital Output Voltage Regulation
      (1) Control shall regulate output voltage to within 0.5% for any loads between no load and full load.
      (2) Voltage drift shall not exceed plus or minus 0.5% for a 60F (33C) change in temperature in an 8 hour period. On engine starting, or sudden load acceptance, voltage is controlled to a maximum of 5% overshoot over nominal level.

(b) Torque-Matched Volts/Hz Overload Control –
(1) Voltage roll-off set point and rate of decay (i.e., the slope of the volts/hertz curve) shall be adjustable in the control.
(2) This function is automatically disabled when the control is in a synchronizing mode.
(c) Fault Current Regulation –
(1) Control shall regulate output current on any phase to a maximum of 3 times rated current under fault conditions for both single phase and three phase faults.
(2) In conjunction with a permanent magnet generator, it shall provide 3 times rated current on all phases for motor starting and short circuit coordination purposes.

g. Protective Functions
1) Alternator Protection
(a) Generator set relaying shall be utility grade equipment.
(b) Supplier shall demonstrate that the relays and settings are coordinated with the alternator thermal damage curve.
(c) The following relay functions shall be included:
(1) Over Current Warning
(2) Over Current Shutdown (51)
(3) Short Circuit Shutdown
(4) High AC Voltage Shutdown (59)
(5) Low AC Voltage Shutdown (27)
(6) Under Frequency Shutdown (81u)
(7) Over Frequency Shutdown/Warning (81o)
(8) Over Load (kW) Warning
(9) Reverse Power Shutdown (32)
(10) Sync Check (25)
(11) Fail To Synchronize Warning or Shutdown
(12) Phase Sequence Sensing Shutdown
(13) Reverse Var Shutdown
2) Engine Protection
(a) Overspeed Shutdown
(b) Low Lube Oil Pressure Shutdown
(c) Low Lube Oil Pressure Warning
(d) High Coolant Temperature Shutdown
(e) High Coolant Temperature Warning
(f) Low Coolant Pressure Warning/Shutdown
(g) Low Coolant Level Warning/Shutdown
(h) Low Coolant Temperature Warning.
(i) Low and High Battery Voltage Warning
(1) Discharged Battery Protection.
(j) Weak Battery Warning
(k) Fail to Start (Overcrank) Shutdown
(1) Fail to Crank Shutdown
(l) Redundant Starter Disconnect
(m) Redundant Speed Sensors
(1) Low Fuel-Day Tank and Low Fuel-Main Tank warning.
(n) Cranking Lockout.
(1) Sensor Failure Indication.
(o) High Crankcase Blowby Level warning.

(p) High Fuel Temperature Warning.
(1) High Intake Manifold Temperature/Pressure
(q) Aftercooler Cooler Inlet Over Temperature

h. Control Power
1) Control power for the generator set monitoring, metering, protection and control system shall be derived from the generator set 24VDC starting batteries

C. The generator set shall be provided with a utility grade protective relay, designed to provide thermal overload protection for the alternator, and performance certified for that purpose by a 3rd party testing organization. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided. Relay shall be installed to allow shutdown of the generator excitation system on an alternator overload condition, with the engine operating for a cool-down period before shutdown. The relay shall not include an instantaneous trip function.

D. Control Interfaces for Remote Monitoring:
1. No field connections for control devices shall be made in the AC power output enclosure. Provide the following features in the control system:
2. Form "C" dry contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.
3. One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.
4. A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
5. A fused 20 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.
6. The control shall be provided with a direct serial communication link for the communication network interface as described elsewhere in this specification and shown on the drawings.

2.06 OTHER EQUIPMENT TO BE PROVIDED WITH THE GENERATOR SET

A. Provide a 20-light LED type remote alarm annunciator with horn, located as shown on the drawings or in a location that can be conveniently monitored by facility personnel. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems; and in addition shall provide indications for high battery voltage, low battery voltage, loss of normal power to the charger. Spare spaces shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2.

B. Outdoor Sound Attenuated Enclosure Level 2 Type
1. The generator set shall be provided with an outdoor sound attenuated enclosure, capable of an eight position average maximum of 79dBA at 23 feet with the entire package listed under UL2200. The package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing. The total assembly of generator set, enclosure, and sub-base fuel tank (when used) shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 100F. The housing shall have hinged access doors as required to maintain easy access for all operating and service functions. All

doors shall be lockable, and include retainers to hold the door open during service. Enclosure roof shall be cambered to prevent rainwater accumulation. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.

2. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturers standard color using a two step electrocoating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:
   a. Primer thickness, 0.5-2.0 mils. Top coat thickness, 0.8-1.2 mils.
   b. Gloss, per ASTM D523-89, 80% plus or minus 5%. Gloss retention after one year shall exceed 50%.
   c. Crosshatch adhesion, per ASTM D3359-93, 4B-5B.
   d. Impact resistance, per ASTM D2794-93, 120-160 inch-pounds.
   e. Salt Spray, per ASTM B117-90, 1000+ hours.
   f. Humidity, per ASTM D2247-92, 1000+ hours.
   g. Water Soak, per ASTM D2247-92, 1000+ hours.
3. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
4. Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.
5. A factory-mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections.
6. The enclosure shall include the following:
   a. Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves
   b. External radiator fill provision.
   c. 100 Amp, 120/208V single phase Distribution Panel
   d. Motor operated intake damper. Damper shall be 24VDC, spring closed, motor open.
   e. Gravity operated exhaust damper.
   f. AC/DC Lights installed and wired inside enclosure
   g. Convenience receptacle

C. Subbase Fuel Tank
   1. Regulatory Requirements: Comply with requirements of the EPA (federal), state (DEP), and local environmental-protection authorities having jurisdiction. Contractor shall obtain and/or complete all permits, registration forms, etc. in conjunction with the installation of the fuel storage tank. Provide copies and/or originals of all required paperwork as directed by the Department. Include recording of fuel oil storage tanks and monitoring of tanks and piping.
      a. Pennsylvania Labor & Industry (L&I) Flammable & Combustible Liquids and Department of Environmental Protection (DEP) Storage Tanks Division Regulations.
      b. Pennsylvania "Storage Tank and Fuel Prevention ACT (ACT 32-1989).
      c. Installer Qualifications: Pennsylvania Department of Environmental Protection (PA DEP) certified installer / inspector with a minimum of five (5) years of experience for similar fuel oil storage tank installations. Installer shall review installation drawings, coordinate timing / staging of fuel tank / weatherproof enclosure, and provide guidance / oversight to the Contractor prior to the installation of the fuel tank. The installer shall inspect the fuel tank, piping connections, etc. to ensure compliance with all regulatory requirements.
         1) Procure all required PA DEP, & Labor & Industries permitting. Certified Installer Assistance, and Testing Procedures.

2. Sub-base fuel tank for the generator set is sized at 4500 gallon. The sub-base fuel tank shall be UL142 listed and labeled. Installation shall be in compliance to NFPA37 and all certifications and permitting to be in accordance with DEP, which includes site test and inspection by a DEP certified tank inspector. The fuel tank shall be a double-walled, steel construction and include the following features:
    a. Emergency tank and basin vents.
    b. Mechanical level gauge.
    c. Fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by the engine manufacturer and in compliance to UL2200 and NFPA 37 requirements.
    d. Leak detection provisions, wired to the generator set control for local and remote alarm indication.
    e. High and low level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level
    f. Basin drain.
    g. Integral lifting provisions.
    h. Local/Remote generator fuel fill/alarm panel with 5 gallon spill containment
        1) The following devices shall be mounted together inside the facility as directed by the Professional
            (a) Visual and Audible alarm panel that initiates on tank leak, low level (30%), full (95%) and overfill (98%)
            (b) Generator Remote Annunciator

D. Maintenance Catwalk Platforms and Stairs
1. Catwalk shall be constructed of Aluminum material, no exceptions. Catwalk shall attach to the generator's concrete base (equipment pad). Catwalk shall be designed to allow access to all genset enclosure doors, control panel, and maintenance items and to permit doors to open 180 degrees without contact with the base or railing. Provide a catwalk on each side of the generator set enclosure.
    a. Stairs: Slip resistant surface. Provide an entry/exit stair on one end of each catwalk. Stairs shall be placed so that they are easily accessible from grade.
    b. Railings: Provide on each side not in contact with the enclosure.
    c. Height: approximately same height as the top of the fuel tank
    d. Finish: Bare Aluminum.

2.07 SEQUENCE OF OPERATION

A. Generator set shall start on receipt of a start signal from one or more of the system Automatic Transfer Switches (ATS's). The start signal shall be via hardwired connection to the generator set control.

B. The generator set shall complete a time delay start period as programmed into the control.

C. The generator set control shall initiate the starting sequence for the generator set.

D. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate "fail to crank" shutdown.

E. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate "fail to start".

F. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to

rated voltage.

G. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous state.

H. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.

I. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.

J. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

PART 3 – EXECUTION

3.01 FACTORY TESTING

A. The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. Equipment supplied shall be fully tested at the factory for function and performance.

B. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

3.02 INSTALLATION

A. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

C. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer’s instructions and seismic requirements of the site.

D. Equipment shall be initially started and operated by representatives of the manufacturer.

E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

3.03 ON-SITE ACCEPTANCE TEST:

A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel for all tests supplied by Contractor. The Professional shall be notified in advance and shall have the option to witness the tests.

B. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

C. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

D. Perform a generator to generator paralleling test. Test shall be conducted by paralleling the generator sets and transferring the building load to and from the generator sets in a “make before break” type connection. Also perform a base load test on the generator sets to confirm load sharing capabilities.

E. Contractor shall refill the fuel tanks of both the new and existing generators following successful completion of all tests and final acceptance of the installation by the owner.

3.04 TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility Department.

3.05 SERVICE AND SUPPORT

A. The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.

B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

3.06 WARRANTY

A. The generator set and associated equipment shall be warranted for a period of not less than 5 years from the date of commissioning against defects in materials and workmanship. The total number of running hours is limited to 1500-hrs.

B. The warranty shall be comprehensive for the first two years covering parts and labor. The remaining 3 years will be parts only.

END OF SECTION

SECTION 26 3600
TRANSFER SWITCHES

PART 1 GENERAL

1.01 RELATED DOUCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
   1. Automatic transfer switches.
   2. Includes bypass/isolation transfer switches.

1.03 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0529 - Hangers and Supports for Electrical Systems.

D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 0573 - Power System Studies: Additional criteria for the selection of equipment specified in this section.

F. Section 26 3213 - Engine Generators: For interface with transfer switches.
   1. Includes code requirements applicable to work of this section.

1.04 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. NEMA ICS 10 Part 1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

E. NFPA 70 - National Electrical Code.

F. NFPA 110 - Standard for Emergency and Standby Power Systems.

G. UL 1008 - Transfer Switch Equipment.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
      a. Engine Generators: See Section 26 3213.
   2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work with placement of supports, anchors, etc. required for mounting.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.

B. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
   1. Clearly indicate whether proposed short circuit current ratings are based on testing with specific overcurrent protective devices or time durations; indicate short-time ratings where applicable.

C. Evidence of qualifications for installer.

D. Source quality control test reports.

E. Field quality control test reports.

F. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

G. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

1.07 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for system Level specified in Section 26 3213.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with power transfer systems of similar size, type, and complexity; manufacturer's authorized installer.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

1.09 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

A. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Transfer Switches:
   1. ASCO Power Technologies: www.ascopower.com/#sle.
   2. Eaton Corporation: www.eaton.com/#sle.
   3. Or approved equal.

B. Source Limitations: Furnish transfer switches and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 TRANSFER SWITCHES

A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Applications:
   1. Utilize open transition transfer unless otherwise indicated or required.
   2. For transfer of highly inductive loads (e.g. large motors and transformers), utilize open transition transfer with in-phase monitor or delayed transition transfer.
   3. Neutral Switching (Single Phase, Three Wire and Three Phase, Four Wire Systems):
      a. Unless otherwise indicated or required, provide neutral switching:
         1) For systems with ground fault protection.
         2) Where the alternate/emergency source is a separately derived system.
   4. Provide signal before transfer contacts for transfer switches serving elevators.

D. Construction Type: Either "contactor type" (open contact) or "breaker type" (enclosed contact) transfer switches complying with specified requirements are acceptable.

E. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).

F. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.

G. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.

H. Switching Methods:
   1. Open Transition:
      a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
      b. Where in-phase transfer is indicated, utilize in-phase monitor to initiate transfer when phase angle difference between sources is near zero to limit in-rush currents.
   2. Delayed Transition:
      a. Provide break-before-make transfer with programmable time delay in a neutral position not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
   3. Neutral Switching: Use simultaneously switched neutral (break-before-make) method. Overlapping neutral method is not acceptable.
   4. Obtain control power for transfer operation from line side of source to which the load is to be transferred.

I. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.

J. Enclosures:
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1 or Type 12.
   2. Finish: Manufacturer's standard unless otherwise indicated.

K. Short Circuit Current Rating:
   1. Withstand and Closing Rating: Provide transfer switches, when protected by the supply side overcurrent protective devices to be installed, with listed withstand and closing rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.

L. Automatic Transfer Switches:
   1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
   2. Control Functions:
      a. Automatic mode.
      b. Test Mode: Simulates failure of primary/normal source.
      c. Voltage and Frequency Sensing:
         1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.
         2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.
         3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.
      d. Outputs:
         1) Contacts for engine start/shutdown (except where direct generator communication interface is provided).
         2) Auxiliary contacts; one set(s) for each switch position.
         3) Signal before transfer (load disconnect) contacts; for selective load disconnection prior to transfer.
      e. Adjustable Time Delays:
         1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.
         2) Transfer to alternate/emergency source time delay.
         3) Retransfer to primary/normal source time delay.
         4) Signal before transfer (load disconnect) contact time delay.
         5) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.
      f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.
      g. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.
   3. Status Indications:
      a. Connected to alternate/emergency source.
      b. Connected to primary/normal source.
      c. Alternate/emergency source available.
   4. Automatic Sequence of Operations:

a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.
b. Where applicable, initiate signal before transfer (load disconnect) contacts at programmable time before transfer.
c. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.
d. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.
e. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.

M. Bypass/Isolation Transfer Switches:
1. Description: Factory-assembled units consisting of interconnected transfer switch and bypass/isolation switch that permits manual bypass and isolation of the transfer switch with connection of the load to either source.
2. Bypass/Isolation Switch Type: Provide overlapping (make-before-break) switches with no interruption of power to load. Load break (break-before-make) switches that interrupt power to load are not acceptable.
3. Bypass/Isolation Operation:
a. Operable from exterior of enclosure.
b. Normal Mode: Provides for normal operation of transfer switch.
c. Test Mode: Provides for operational testing of bypassed transfer switch without affecting power to load.
d. Isolate Mode: Provides for complete isolation of transfer switch from all power sources, permitting removal from unit.

2.03 SOURCE QUALITY CONTROL

A. Perform production tests on transfer switches at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.
C. Verify that rough-ins for field connections are in the proper locations.
D. Verify that mounting surfaces are ready to receive transfer switches.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Arrange equipment to provide minimum clearances and required maintenance access.
D. Provide required support and attachment in accordance with Section 26 0529.
E. Install transfer switches plumb and level.
F. Unless otherwise indicated, mount floor-mounted transfer switches on properly sized 4 inch high concrete pad constructed in accordance with Section 03 3000.
G. Provide grounding and bonding in accordance with Section 26 0526.

H. Identify transfer switches and associated system wiring in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. Prepare and start system in accordance with manufacturer's instructions.

B. Automatic Transfer Switches:
   1. Inspect and test in accordance with NETA ATS, except Section 4.
   2. Perform inspections and tests listed in NETA ATS, Section 7.22.3. The insulation-resistance tests listed as optional are not required.

C. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of transfer switches to Owner, and correct deficiencies or make adjustments as directed.

B. Training: Train Owner's personnel on operation, adjustment, and maintenance of transfer switches.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.06 PROTECTION

A. Protect installed transfer switches from subsequent construction operations.

END OF SECTION

SECTION 26 4113
LIGHTNING PROTECTION FOR STRUCTURES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to the requirements of this section.

1.02 SECTION INCLUDES

A. Strike (air) terminals and interconnecting conductors.

B. Grounding and bonding for lightning protection.

1.03 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems: Electrical system grounds.

B. Surge Protection for Wiring Systems: Specified in individual system requirements.

1.04 REFERENCE STANDARDS

A. NFPA 780 - Standard for the Installation of Lightning Protection Systems.

B. UL 96 - Lightning Protection Components.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination with Concrete Work: Coordinate the embedding of lightning protection components in concrete.

B. Coordination with Roofing Work: Ensure adequate attachment of strike terminals and conductors without damage to roofing.

C. Preinstallation Meeting: Convene a meeting at least at least two weeks prior to commencement of any work affected by lightning protection system requirements to discuss prerequisites and coordination required by other installers; require attendance by representatives of installers whose work will be affected.

1.06 SUBMITTALS

A. Shop Drawings: Indicate location and layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.

1. Include engineering analysis of equalization of potential to metal bodies within the structure.

B. Product Data: Provide dimensions and materials of each component, indication of testing agency listing, and installation instructions.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Installation Certification: Submit copy of certification agency's approval.

E. Operation and Maintenance Data: Provide recommended inspection and testing plan, including recommended intervals, to achieve periodic maintenance as recommended in NFPA 780; provide customized plan reflecting actual installation configuration with specific installed components identified.

F. Project Record Documents: Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors in project record documents.

1.07 QUALITY ASSURANCE

A. Maintain one copy of each referenced system design standard on site.

B. Manufacturer Qualifications: Company specializing in lightning protection equipment with minimum three years documented experience.

C. Designer Qualifications: Person or entity, employed by installer, who specializes in lightning protection system design with minimum three years documented experience.

D. Installer Qualifications: Capable of providing the specified certification of the installed system.

E. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 LIGHTNING PROTECTION SYSTEM

A. Lightning Protection System: Provide complete system complying with NFPA 780, including air terminals, bonding, interconnecting conductors and grounding electrodes.
   1. Provide system that protects:
      a. The entire structure.
      b. Open air areas within 100 feet of exterior walls at grade level.
      c. Open air areas within building footprint.
   2. Coordinate with other grounding and bonding systems specified.
   3. Provide copper, bronze, or stainless steel components, except where aluminum is allowed by NFPA 780.
   4. Provide system certified by Underwriters Laboratories or the Lightning Protection Institute.

B. Strike Terminals: Provide strike (air) terminals on the following:
   1. Roofs.
   2. Penthouse roofs.
   3. Parapets.
   4. Roof mounted equipment.

2.02 COMPONENTS

A. All Components: Complying with applicable requirements of UL 96.

B. Strike (Air) Terminals: Copper, solid, with adhesive bases for single-ply roof installations.

C. Grounding Rods: Solid copper.

D. Ground Plate: Copper.

E. Conductors: Copper cable.

F. Connectors and Splicers: Bronze.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated on shop drawings.

B. Coordinate work with installation of roofing and exterior and interior finishes.

3.02 INSTALLATION

A. Install in accordance with referenced system standards and as required for specified certification.

B. Connect conductors using mechanical connectors or exothermic welding process; protect adjacent construction elements and finishes from damage.

3.03 FIELD QUALITY CONTROL

A. Perform visual inspection as specified in NFPA 780 as if this were a periodic follow-up inspection.

B. Perform continuity testing as specified in NFPA 780 as if this were testing for periodic maintenance.

C. Obtain the services of the specified certification agency to provide inspection and certification of the lightning protection system, including performance of any other testing required by that agency.

END OF SECTION

SECTION 26 4300
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Surge protective devices for service entrance locations.

B. Surge protective devices for distribution locations.

C. Surge protective devices for branch panelboard locations.

1.03 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 2413 - Switchboards.

C. Section 26 2416 - Panelboards.

1.04 ABBREVIATIONS AND ACRONYMS

A. SPD: Surge Protective Device.

1.05 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

D. NFPA 70 - National Electrical Code.

E. UL 1449 - Standard for Surge Protective Devices.

1.06 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.07 SUBMITTALS

A. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.

B. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.

C. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
   1. UL 1449.

D. Field Quality Control Test Reports.

E. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

F. Project Record Documents: Record actual connections and locations of surge protective devices.

1.08 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.09 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.10 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.11 WARRANTY

A. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Factory-installed, Internally Mounted Surge Protective Devices:
   1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

B. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Unless otherwise indicated, provide factory-installed, internally-mounted SPDs.

C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

D. Protected Modes:
   1. Wye Systems: L-N, L-G, N-G, L-L.

E. UL 1449 Voltage Protection Ratings (VPRs):
   1. 208Y/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
   2. 480Y/277V System Voltage: Not more than 1,500 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.

F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

G. Enclosure Environment Type per NEMA 250: As indicated on the drawings.

H. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
   1. Switchboards: See Section 26 2413.
   2. Panelboards: See Section 26 2416.

2.03 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Surge Protective Device:

1. Protection Circuits: Field-replaceable modular.
2. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. Diagnostics:
    a. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
    b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
    c. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
6. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.04 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Surge Protective Device:
1. Protection Circuits: Field-replaceable modular.
2. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. Diagnostics:
    a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
    b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
    c. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
6. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.05 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Surge Protective Device:
1. Protection Circuits: Field-replaceable modular.
2. Surge Current Rating: Not less than 60 kA per mode/120 kA per phase.
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. Diagnostics:
    a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
    b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
    c. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
6. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify system grounding and bonding is in accordance with Section 26 0526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

C. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.

D. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 0526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS Section 7.19.1.

3.04 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 5100
INTERIOR LIGHTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Interior luminaires.

B. Exit signs.

C. Ballasts and drivers.

D. Accessories.

1.03 RELATED REQUIREMENTS

A. Section 26 0529 - Hangers and Supports for Electrical Systems.

B. Section 26 0533.16 - Boxes for Electrical Systems.

C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 0923 - Lighting Control Devices.

E. Section 26 2726 - Wiring Devices: Manual wall switches and wall dimmers.

F. Section 26 5600 - Exterior Lighting.

1.04 REFERENCE STANDARDS

A. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.

B. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction.

D. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems.

E. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems.

F. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility.

G. NFPA 70 - National Electrical Code.

H. NFPA 101 - Life Safety Code.

I. UL 924 - Emergency Lighting and Power Equipment.

J. UL 1598 - Luminaires.

K. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.

3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.06 SUBMITTALS

A. Shop Drawings:
   1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
   2. Provide photometric calculations where luminaires are proposed for substitution upon request.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
   1. LED Luminaires:
      a. Include estimated useful life, calculated based on IES LM-80 test data.

C. Field quality control reports.

D. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

E. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.09 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

A. Provide three year manufacturer warranty for LED luminaires, including drivers.

B. Provide ten year pro-rata warranty for batteries for self-powered exit signs.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and

protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Recessed Luminaires:
   1. Ceiling Compatibility: Comply with NEMA LE 4.

H. LED Luminaires:
   1. Components: UL 8750 recognized or listed as applicable.
   2. Tested in accordance with IES LM-79 and IES LM-80.
   3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

I. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.03 EXIT SIGNS

A. Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.
   1. Number of Faces: Single- or double-face as indicated or as required for installed location.
   2. Directional Arrows: As indicated or as required for installed location.

B. Powered Exit Signs: Internally illuminated with LEDs unless otherwise indicated.
   1. Self-Powered Exit Signs:
      a. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
      b. Battery: Sealed, maintenance-free, nickel cadmium unless otherwise indicated.
      c. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
      d. Provide low-voltage disconnect to prevent battery damage from deep discharge.
      e. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

2.04 BALLASTS AND DRIVERS

A. Ballasts/Drivers - General Requirements:
   1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
   2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

B. Dimmable LED Drivers:
   1. Dimming Range: Continuous dimming from 100 percent to one percent relative light output unless dimming capability to lower level is indicated, without flicker.
   2. Control Compatibility: Fully compatible with the dimming controls to be installed.

2.05 ACCESSORIES

A. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of luminaires provided under this section.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install products in accordance with manufacturer's instructions.

D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).

E. Provide required support and attachment in accordance with Section 26 0529.

F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

G. Suspended Ceiling Mounted Luminaires:
   1. Do not use ceiling tiles to bear weight of luminaires.
   2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
   3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
   4. Secure pendant-mounted luminaires to building structure.
   5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
   6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gage, connected from opposing corners of each recessed luminaire to building structure.
   7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.

H. Recessed Luminaires:
   1. Install trims tight to mounting surface with no visible light leakage.
   2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.

I. Suspended Luminaires:
   1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
   2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.

3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
4. Install canopies tight to mounting surface.

J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

K. Install accessories furnished with each luminaire.

L. Bond products and metal accessories to branch circuit equipment grounding conductor.

M. Exit Signs:
1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
2. Install lock-on device on branch circuit breaker serving units.

N. Identify luminaires connected to emergency power system in accordance with Section 26 0553.

O. Install lamps in each luminaire.

3.04 FIELD QUALITY CONTROL

A. Inspect each product for damage and defects.

B. Operate each luminaire after installation and connection to verify proper operation.

C. Test self-powered exit signs to verify proper operation upon loss of normal power supply.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.05 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

B. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.06 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.

3.08 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 26 5600
EXTERIOR LIGHTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to the requirements of this section.

1.02 SECTION INCLUDES

A. Exterior luminaires.

B. Ballasts.

C. Luminaire accessories.

1.03 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0533.16 - Boxes for Electrical Systems.

D. Section 26 2726 - Wiring Devices: Receptacles for installation in poles.

E. Section 26 5100 - Interior Lighting.

1.04 REFERENCE STANDARDS

A. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.

B. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction.

D. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems.

E. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility.

F. NFPA 70 - National Electrical Code.

G. UL 1598 - Luminaires.

H. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate placement of poles and associated foundations with Site Contractor. Concrete bases, poles and associated luminaires shall be provided by the Site Contractor and wired by the Electrical Contractor.
2. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.06 SUBMITTALS

A. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
2. Provide photometric calculations where luminaires are proposed for substitution upon request.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, and installed accessories; include model number nomenclature clearly marked with all proposed features.
   1. LED Luminaires:
      a. Include estimated useful life, calculated based on IES LM-80 test data.

C. Field Quality Control Reports.

D. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

E. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.09 WARRANTY

A. Provide three year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

H. Recessed Luminaires:
   1. Ceiling Compatibility: Comply with NEMA LE 4.

I. LED Luminaires:
   1. Components: UL 8750 recognized or listed as applicable.
   2. Tested in accordance with IES LM-79 and IES LM-80.
   3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

J. Exposed Hardware: Stainless steel.

2.03 BALLASTS AND DRIVERS

A. Ballasts/Drivers - General Requirements:
   1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
   2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of luminaires provided under this section.

B. Install products in accordance with manufacturer's instructions.

C. Install luminaires in accordance with NECA/IESNA 501.

D. Provide required support and attachment in accordance with Section 26 0529.

E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

F. Recessed Luminaires:
   1. Install trims tight to mounting surface with no visible light leakage.

G. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

H. Pole-Mounted Luminaires:
   1. Grounding:
      a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
      b. Provide supplementary ground rod electrode as specified in Section 26 0526 at each pole bonded to grounding system as indicated.
   2. Install separate service conductors, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.

I. Install accessories furnished with each luminaire.

J. Bond products and metal accessories to branch circuit equipment grounding conductor.

K. Install lamps in each luminaire.

3.04 FIELD QUALITY CONTROL

A. Inspect each product for damage and defects.

B. Operate each luminaire after installation and connection to verify proper operation.

C. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.05 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.06 CLEANING

A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.

3.08 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 26 5629
SITE LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section includes exterior luminaries, poles, accessories, and handrail lighting.

B. Related Requirements:

1. Section 03 30 00 – Cast-in-Place Concrete: Light pole and bollard foundations.
2. Section 26 05 26 – Grounding and Bonding for Electrical Systems: Bond and ground luminaries, metal accessories, and metal poles.
3. Section 31 23 16.13 – Trenching: Trench backfill depth.

1.3 UNIT PRICE – NOT USED

1.4 REFERENCE STANDARDS

A. American National Standards Institute:
1. ANSI C136 Series - Standards for Roadway and Area Lighting Equipment.
2. ANSI C136.23—Enclosed Architectural Luminaires
3. ANSI C136.37—Solid State Light Sources Used in Roadway and Area Lighting

B. Local Utility Company Standards and Details.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate dimensions and components for each luminaire not standard product of manufacturer. Provide engineered shop drawings for the foundation design of the light fixtures signed and sealed by a licensed professional from Pennsylvania prior to installation.

C. Product Data: Submit dimensions, colors, ratings, and performance data.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

1.8 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

PART 2 - PRODUCTS

2.1 LUMINAIRES; BALLASTS, LAMPS, AND POLES

A. Product Description: Complete exterior luminaire assemblies, with features, options, and accessories as shown and detailed on the Drawings.

B. All fixtures are to be in conformance with the Drawings.

PART 3 - EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove existing exterior luminaries or tower lights, listed to be removed on the Drawings. Contact the County to determine if they are to be disposed. If not, protect and store on-site for removal by the County.

B. Clean and repair any existing exterior luminaries, tower lights, or poles as decided by the County to be reused.

3.2 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and Project conditions.

B. Section 31 23 16.13 – Trenching: Trench backfill depth.

C. Verify foundations are ready to receive fixtures.

3.3 INSTALLATION

A. Section 03 30 00 – Cast-in-Place Concrete: Install concrete bases for lighting poles at locations as indicated on the Drawings.

B. Install poles plumb. Install shims to adjust plumb. Grout around each base.

C. Install lamps in each luminaire.

D. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Bond and ground luminaries, metal accessories, and metal poles.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

3.5 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Aim and adjust luminaries to provide illumination levels and distribution as indicated on Drawings.

3.6 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean photometric control surfaces as recommended by manufacturer.

C. Clean finishes and touch up damage.

3.7 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.

B. Relamp luminaries having failed lamps at Substantial Completion.

END OF SECTION

SECTION 27 1000
STRUCTURED CABLING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Communications system design requirements.

B. Communications pathways.

C. Copper cable and terminations.

D. Fiber optic cable and interconnecting devices.

E. Communications equipment room fittings.

F. Communications outlets.

G. Communications grounding and bonding.

H. Communications identification.

1.03 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0533.13 - Conduit for Electrical Systems.

D. Section 26 0536 - Cable Trays for Electrical Systems.

E. Section 26 0533.16 - Boxes for Electrical Systems.

F. Section 26 0553 - Identification for Electrical Systems: Identification products.

G. Section 26 2726 - Wiring Devices.

H. Division 28 - Security Systems

1.04 REFERENCE STANDARDS

A. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment.

B. ICEA S-83-596 - Indoor Optical Fiber Cables.

C. ICEA S-90-661 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without An Overall Shield) For Use in General Purpose and LAN Communications Wiring Systems Technical Requirements.

D. NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling.

E. NFPA 70 - National Electrical Code.

F. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices.

G. TIA-492CAAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.

H. TIA-526-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.

I. TIA-526-14 - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant.

J. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set.

K. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards.

L. TIA-568.3 - Optical Fiber Cabling and Components Standard.

M. TIA-569 - Telecommunications Pathways and Spaces.

N. TIA-598 - Optical Fiber Cable Color Coding.

O. TIA-606 - Administration Standard for Telecommunications Infrastructure.

P. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

Q. UL 444 - Communications Cables.

R. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.

S. UL 1651 - Fiber Optic Cable.

T. UL 1863 - Communications-Circuit Accessories.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
   2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
   3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Arrange for Communications Service Provider to provide service.

C. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Communications Service Provider representative.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

B. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).

C. Evidence of qualifications for installer.

D. Field Test Reports.

E. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
   1. Record actual locations of outlet boxes and distribution frames.
   2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
   3. Identify distribution frames and equipment rooms by room number on drawings.

F. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.

B. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
   1. Employing a BICSI Registered Communications Distribution Designer (RCDD).

2. Supervisors and installers factory certified by manufacturers of products to be installed.

C. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Keep stored products clean and dry.

1.09 WARRANTY

A. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Products shall be as manufactured by Commscope or approved equal.

B. All products shall be of a single manufacturer.

2.02 SYSTEM DESIGN

A. Provide a complete permanent system of cabling and pathways for voice, data and security outlets and devices, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
   1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
   2. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
   3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
   4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.

B. Main Distribution Frame (MDF): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets, functioning as point of presence to external service provider.
   1. Locate main distribution frame as indicated on the drawings.

C. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
   1. Locate intermediate distribution frames as indicated on the drawings.

D. Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.

E. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.03 PATHWAYS

A. Conduit: As specified in Section 26 0533.13; provide pull cords in all conduit.

B. Cable Trays: As specified in Section 26 0536.

C. Underground Service Entrance: Rigid polyvinyl chloride (PVC) conduit, Schedule 40.

D. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

2.04 COPPER CABLE AND TERMINATIONS

A. Provide cables with lead content less than 300 parts per million.

B. Copper Backbone Cable:

1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2, ICEA S-90-661, and listed and labeled as complying with UL 444; arranged in 25-pair binder groups.
2. Cable Type: TIA-568.2 Category 5e UTP (unshielded twisted pair); 24 AWG.
3. Cable Capacity: Quantity of pairs as indicated on drawings.
4. Cable Applications:
    a. Plenum Applications: Use listed NFPA 70 Type CMP plenum cable.
    b. Riser Applications: Use listed NFPA 70 Type CMR riser cable or Type CMP plenum cable.
5. Product(s):
    a. CommScope; SYSTIMAX Twisted Pair Cables: www.commscope.com/#sle.

C. Copper Horizontal Cable:
1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
2. Cable Type - Voice and Data and Security: TIA-568.2 Category 6 UTP (unshielded twisted pair); 23 AWG.
3. Cable Capacity: 4-pair.
4. Cable Applications: Use listed NFPA 70 Type CMP plenum cable unless otherwise indicated.
5. Cable Jacket Color -Data Cable: Blue.
6. Cable Jacket Color - Voice Cable: White.
7. Cable Jacket Color - Security Cable: Yellow.
8. Cable Jacket Color - WAPs: Green.
9. Product(s):
    a. CommScope; SYSTIMAX Twisted Pair Cables; GigaSPEED XL Category 6 U/UTP Cable: www.commscope.com/#sle.

D. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.

E. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
1. Performance: 500 mating cycles.
2. Voice, Data and Security Jacks: 8-position modular jack, color-coded for both T568A and T568B wiring configurations.
3. Product(s):
    a. CommScope; SYSTIMAX RJ45 Jacks; MGS400 Series Category 6 U/UTP Modular Jacks: www.commscope.com/#sle.

F. Copper Patch Cords:
1. Description: Factory-fabricated 4-pair cable assemblies with 8-position modular connectors terminated at each end.
2. Patch Cords for Patch Panels:
    a. Quantity: One for each pair of patch panel ports.
    b. Length: 10 feet. Verify final length with Owner prior to purchasing.
3. Patch Cords for Work Areas:
    a. Quantity: One for each work area outlet port.
    b. Length: 10 feet. Verify final length with Owner prior to purchasing.
4. Product(s):
    a. CommScope; SYSTIMAX Category 6 U/UTP Patch Cords: www.commscope.com/#sle.

2.05 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

A. Fiber Optic Backbone Cable:
   1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568.3, TIA-598, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
   2. Cable Type: Single-mode, 8.3/125 um (OS1) complying with TIA-492CAAA
   3. Cable Type: Multi-mode, 50/125 um (OM2) complying with TIA-492AAAB
   4. Cable Capacity: Quantity of fibers as indicated on drawings.
   5. Cable Applications:
      a. Plenum Applications: Use listed NFPA 70 Type OFNP plenum cable.
   6. Cable Jacket Color:
      a. Multimode Fiber (OM1/OM2): Orange.
      b. Single-Mode Fiber (OS1/OS2): Yellow.
   7. Product(s):
      a. CommScope Fiber Optic Cables; TeraSpeed Fiber: www.commscope.com/#sle..

B. Fiber Optic Interconnecting Devices:
   1. Connector Type: Type LC.
   2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
   3. Maximum Attenuation/Insertion Loss: 0.3 dB.
   4. Product(s):
      a. CommScope Fiber Optic Connectors; QWIK II-LC Fiber Connectors: www.commscope.com/#sle.

C. Fiber Optic Patch Cords:
   1. Description: Factory-fabricated 2-fiber cable assemblies with suitable connectors at each end.
   2. Patch Cords for Patch Panels:
      a. Quantity: One for each pair of patch panel ports.
      b. Length: 10 feet. Verify final length with Owner prior to purchasing.
   3. Patch Cords for Work Areas:
      a. Quantity: One for each work area outlet port.
      b. Length: 10 feet. Verify final length with Owner prior to purchasing.
   4. Product(s):
      a. CommScope Fiber Optic Patch Cords; TeraSpeed Fiber Patch Cords: www.commscope.com/#sle.

2.06 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

A. Copper Cross-Connection Equipment:
   1. Connector Blocks for Category 5e and Up Cabling: Type 110 insulation displacement connectors; capacity sufficient for cables to be terminated plus 30 percent spare.
   2. Patch Panels for Copper Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.
      a. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
      b. Capacity: Provide ports sufficient for cables to be terminated plus 30 percent spare.
      c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
      d. Provide incoming cable strain relief and routing guides on back of panel.
   3. Product(s):
      a. CommScope; SYSTIMAX Copper Panels; 360-IPR-1100-XX Series Patch Panels: www.commscope.com/#sle.

B. Fiber Optic Cross-Connection Equipment:
   1. Patch Panels for Fiber Optic Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
      a. Adapters: As specified above under FIBER OPTIC CABLE AND INTERCONNECTING DEVICES; maximum of 24 duplex adaptors per standard panel width.
      b. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
      c. Provide incoming cable strain relief and routing guides on back of panel.
      d. Provide rear cable management tray at least 8 inches deep with removable cover.
      e. Provide dust covers for unused adapters.
   2. Product(s):
      a. CommScope; SYSTIMAX Fiber Panels; HD Series Patch Panels: www.commscope.com/#sle.

C. Backboards: Interior grade plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.
   1. Size: As indicated on drawings.
   2. Do not paint over UL label.

D. Equipment Frames, Racks and Cabinets:
   1. Component Racks: EIA/ECA-310 standard 19 inch wide.
   2. Floor Mounted Racks: Aluminum or steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug.
      a. 4-post rack
      b. Dimensions (see drawings for rack size in each area):
         1) 19" wide by 84" high by 36" deep. (CommScope 760082560)
         2) 19" wide by 84" high by 30" deep. (CommScope 760082529)
      c. Black finish

E. Cable Management:
   1. Provide 2U horizontal cable management below each fiber and copper patch panel.
      a. Product: CommScope Horizontal Cable Managers; HCM-SS-XX-XX Series: www.commscope.com/#sle.

2.07 COMMUNICATIONS OUTLETS

A. Outlet Boxes: Comply with Section 26 0533.16.
   1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
   2. Minimum Size, Unless Otherwise Indicated:
      a. Voice/Data/Security Outlets: 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.

B. Wall Plates:
   1. Comply with system design standards and UL 514C.
   2. Accepts modular jacks/inserts.
   3. Capacity: As indicated on the drawings.
   4. Wall Plate Material/Finish - Flush-Mounted Outlets: Match wiring device and wall plate finishes specified in Section 26 2726.

2.08 RACK EQUIPMENT, NETWORK SWITCHES AND UNINTERRUPTIBLE POWER SUPPLIES

A. All telephone/data rack equipment and network switches shall be provided by the Owner.
   1. All telephone/data rack equipment and networkswitches shall be backed up by rack-mounted UPSs provided by the Owner. Coordinate with Owner final size of UPS to

ensure proper electrical connections to UPSs are provided by Contractor.

B. All security rack equipment and network switches shall be provided in accordance with Division 28 specifications and Contract Documents.
   1. All security rack equipment and network switches in MDF and IDFs shall be backed up by rack-mounted UPSs provided by Contactor.
      a. Provide UPSs to provide battery backup for a minimum duration of 15 minutes.
      b. Provide 120/208VAC, single-phase, 60Hz UPS with +/-1% voltage regulation, +/-5% voltage adjustment range, 60Hz+0.1% frequency while the input voltage varies between +10% and -25% voltage range and 60Hz +/-5% frequency range, and with 150% of full load.
      c. The UPS shall be UL Listed per UL Standard 1778 and shall be CSA certified.
      d. Output load capacity of the UPS shall be as required to provide the runtime for all equipment indicated, plus 25% spare capacity.
      e. Battery Cells: Sealed, lead-acid, valve-regulated.
      f. Recharge Time: to 95% capacity within ten (10) times discharge time.
      g. The UPS shall be designed to operate and an on-line reverse transfer system in the following modes:
         1) Normal: The critical AC load is continuously supplied by the UPS inverter. The rectifier/charger derives power from a utility AC source and supplies DC power to the inverter while simultaneously float-charging a power reserve battery.
         2) Emergency: Upon failure of utility AC power, the critical AC load is supplied by the inverter, which without any switching, obtains power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.
         3) Recharge: Upon restoration of utility AC power, after a utility AC power outage, the rectifier/charger shall automatically restart, walk-in, and gradually assume the inverter and battery/recharge loads.
         4) Bypass: If the UPS must be taken out of service for maintenance or repair, or should the inverter overload capacity be exceeded, the static transfer switch shall perform a reverse transfer of the load from the inverter to bypass source with no interruption in power to the critical AC load.
      h. AC Input to UPS
         1) Voltage configuration for standard units: one-phase, 2-wire plus ground.
         2) Voltage range: +10%, -25% of nominal.
         3) Frequency: +/-5% of nominal.
         4) Power Factor: 0.90 lagging minimum at nominal input voltage and full rated UPS output load.
         5) Inrush current: 800% of full load current maximum.
         6) Current Limit: 125% of nominal AC input current maximum. 100% of nominal for optional generator operation.
         7) Input Current walk-in: 20 seconds to full rated input current maximum. Field selectable 5 or 20 seconds.
         8) Current distortion: 30% THD maximum at full load. An optional input filter shall be available to reduce input current distortion to 10% THD maximum at full load.
         9) Surge protection: Sustains input surges without damage per criteria listed in ANSI C62.41-1980.
      i. AC output, UPS Inverter
         1) Voltage Configuration: one-phase, 2-wire plus ground.
         2) Voltage Regulation: +/-1% 120 VAC RMS average for a 150% load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature, and load power factor.

3) Frequency: Nominal frequency +/-0.1%. Frequency Slew Rate: 1.0 Hz per second maximum. Field selectable from 0.1 to 1.0 Hz per second.
4) Phase Displacement: +/-1 degree for balanced load.
5) Bypass Line Sync Range: +/-0.5Hz. Field selectable +/-0.5, 1.0, 3.0, 5.0 Hz.
6) Voltage Distortion: 5% total harmonic distortion (THD) for linear loads, 3% maximum for any single harmonic.
7) Load Power Factor Range: 0.9 leading to 0.5 lagging.
8) Output Power Rating: Rated kVA at 0.8 lagging power factor
9) Overload Capability: 125% for 10 minutes (without bypass source); 150% for 30 seconds (without bypass source)
10) Inverter Output Voltage Adjustment: +/-5% manual adjustment.
11) Voltage Transient Response:
    (a) 20% load step +/-4%.
    (b) 30% load step +/-5%.
    (c) 50% load step +/-8%.
    (d) Loss or return of AC input power +/-1%.
    (e) Manual transfer of 100% load +/-4%.
12) Transient Recovery Time: to within 1% of output voltage within 50 milliseconds.
13) Fault Clearing: Sub-cycle current of at least 300%.

j. Environmental Conditions:
1) Operating Ambient Temperature: UPS Module 32 degrees F to 105 degrees F.
2) Storage/Transport Ambient Temperature: -4 degrees F to 158 degrees F.

k. Manufacturers:
1) APC
2) Eaton
3) Liebert
4) Approved Equal

2. All security network switches shall be provided in accordance with specification 28 4000 'Control Systems for Security'. Provide security network switches as required for a complete functioning system.

2.09 GROUNDING AND BONDING COMPONENTS

A. Comply with TIA-607.

B. Comply with Section 26 0526.

2.10 IDENTIFICATION PRODUCTS

A. Comply with TIA-606.

B. Comply with Section 26 0553.

2.11 SOURCE QUALITY CONTROL

A. Factory test cables according to TIA-568 (SET).

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), NECA/BICSI 568, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

B. Comply with Communication Service Provider requirements.

C. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.

D. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

3.02 INSTALLATION OF PATHWAYS

A. Install pathways with the following minimum clearances:
   1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
   2. 12 inches from power conduits and cables and panelboards.
   3. 5 inches from fluorescent and high frequency lighting fixtures.
   4. 6 inches from flues, hot water pipes, and steam pipes.

B. Conduit, in Addition to Requirements of Section 26 0533.13:
   1. Arrange conduit to provide no more than the equivalent of two 90 degree bend(s) between pull points.
   2. Conduit Bends: Inside radius not less than 10 times conduit internal diameter.
   3. Arrange conduit to provide no more than 100 feet between pull points.
   4. Do not use conduit bodies.

C. Outlet Boxes:
   1. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of telecommunications outlets provided under this section.
      a. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
      b. Provide minimum of 24 inches horizontal separation between flush mounted outlet boxes installed on opposite sides of fire rated walls.
      c. Unless otherwise indicated, provide separate outlet boxes for line voltage and low voltage devices.
      d. Locate outlet boxes so that wall plate does not span different building finishes.
      e. Locate outlet boxes so that wall plate does not cross masonry joints.

3.03 INSTALLATION OF EQUIPMENT AND CABLING

A. Cabling:
   1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
   2. Do not over-cinch or crush cables.
   3. Do not exceed manufacturer's recommended cable pull tension.
   4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.

B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
   1. At Distribution Frames: 120 inches.
   2. At Outlets - Copper: 12 inches.

C. Copper Cabling:
   1. Category 5e and Above: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
   2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
   3. Use T568B wiring configuration.

D. Fiber Optic Cabling:
   1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
   2. Support vertical cable at intervals as recommended by manufacturer.

E. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.

F. Identification:
   1. Use wire and cable markers to identify cables at each end.
   2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
   3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.

3.04 FIELD QUALITY CONTROL

A. Comply with inspection and testing requirements of specified installation standards.

B. Visual Inspection:
   1. Inspect cable jackets for certification markings.
   2. Inspect cable terminations for color coded labels of proper type.
   3. Inspect outlet plates and patch panels for complete labels.

C. Testing - Copper Cabling and Associated Equipment:
   1. Test backbone cables after termination but before cross-connection.
   2. Test backbone cables for DC loop resistance, shorts, opens, intermittent faults, and polarity between connectors and between conductors and shield, if cable has overall shield.
   3. Test operation of shorting bars in connection blocks.
   4. Category 5e and Above Backbone: Perform near end cross talk (NEXT) and attenuation tests.
   5. Category 5e and Above Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.

D. Testing - Fiber Optic Cabling:
   1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
   2. Multimode Backbone: Perform tests in accordance with TIA-526-14.
   3. Single Mode Backbone: Perform tests in accordance with TIA-526-7.

E. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

END OF SECTION

SECTION 27 4133
CATV SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 DESCRIPTION

A. This section lists the equipment that is required for the CATV wiring in the buildings and the CATV trunk system.

B. For testing purposes, the contractor shall use a sweep generator.

C. The Contractor shall assume that the CATV signal at the point of entry in the building is between +10 to +12 dBmV with ±2 dB signal slope. The amplifiers and other CATV systems shall be designed for this signal level to the building.

D. In each location, the CATV shall be home run to a TAP port in the Data closet. No daisy-chaining of CATV wiring is permitted for the rooms.

E. Provide distribution amplifiers, splitters, wall plates, plugs, etc., as required.

F. At appropriate locations as shown, terminated or through-line TAP offs of appropriate port count shall be used.

G. Provide signal quality at every outlet as specified.

H. Provide all patch cables for each television location. Length of patch cable shall be coordinated with Owner's IT Department.

I. Terminate all CATV cables in F-connector on patch bands. Provide jumper cables to splitters on the wall or elsewhere.

1.03 SUBMITTALS

A. The submittals must include a riser diagram with all cable outlets, cable types, tap settings, amplifiers, etc. all design calculations for the system and catalog cuts of all equipment. The Contractor shall not install any of this equipment until their design is approved.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. All products shall be manufactured by Blonder Tongue or approved equal.

2.02 DISTRIBUTION AMPLIFIER (INDOOR INSTALLATION)

A. This device is used to increase the signal level along the distribution system. Two gain levels are specified based on application requirements. These gains are shown as representative equipment only. The bidders shall determine their own equipment requirements.

B. The technical specifications are given below:
   1. Bandwidth: 50 to 1000 MHZ
   2. Full gain forward amplifier
      a. 33 dB
      b. 49 dB
   3. Full gain reverse amplifier (when required) shall be 24 dB.
   4. Output level: +44 dBmV
   5. The flatness shall be ± 075 dB.
   6. The gain control range shall be 15 dB.
   7. Slope control range shall be 10 dB.

8. Input return loss shall be 14 dB.
9. Output return loss shall be 14 dB.
10. Noise figure shall be 9.0 dB.
11. The composite triple beat shall be –54 dB.
12. Cross modulation shall be –58 dB.
13. Second order inter-modulation shall be –55 dB.
14. Hum modulation shall be –70 dB.
15. Input/output test point level shall be –30 dB.
16. Operating temperature shall be –40 to + 60°C.
17. Connectors shall be RF in and out, “F” Type, -30 dB test points in and out, “F” Type.
18. The unit shall use plug-in attenuators.
19. Power requirements: 117 volt AC, 60 Hz, 0.5 amps.
20. Dimensions: 12 inches by 8 inches by 3 inches, maximum.

C. Provide plug-in attenuators, as required.

D. The amplifier must pair T-channels.

2.03 SPLITTERS AND TAP OFFS

A. The devices are used to divide the trunk signal to each television receiver.

B. The technical specifications shall be as follows:
1. Bandwidth: 5 – 1000 MHZ minimum
2. The equipment shall have metal housing with F-connectors
3. The technical specifications for four output units shall be as follows:
a. Splitter loss
1) 7.2 dB (5 – 500 MHZ)
2) 8.5 dB (600 – 750 MHZ)
3) 8.0 dB (500 – 600 MHZ)
b. Input return loss = 18 dB min.
c. Isolation between outputs = 27 dB min.
d. RFI shield to 80 dB.
e. The connector orientation shall be L-shape.
4. The technical specification for eight output units shall be as follows:
a. Splitter loss:
1) 12.0 dB (5 – 450 MHZ)
2) 14.0 dB (600 – 750 MHZ)
3) 13.5 dB (450 – 600 MHZ)
b. Input return loss = 14 dB min.
c. Isolation between outputs = 27 dB min.
d. RFI shielded to 80 dB.
e. The connector orientation shall be L-shape.

2.04 DIRECTIONAL COUPLER WALL TAPS

A. These devices are used to divide the trunk signal to each television receiver.

B. The technical specifications shall be as follows:
1. Bandwidth: 5 to 1000 MHZ, minimum
2. No. of outputs in one (1).
3. Impedance: 75 ohm.
4. Connector: Type “F”
5. The isolation and through loss shall be as follows:
a. RFI Isolation dB; SUB; VHF; UHF/CATV
1) 4; 3.5; 3.5; 4.0

2) 6; 3.0; 3.0; 3.5
3) 9; 1.2; 1.2; 1.6
4) 12; 0.9; 0.9; 1.5
5) 16; 0.7; 0.7; 0.7
6) 20; 0.6; 0.6; 0.7
7) 24; 0.5; 0.5; 0.6
8) 27; 0.5; 0.5; 0.6
9) 30; 0.5; 0.5; 0.6

6. Insertion loss: 0.5 to 4.0 dB
7. Coupling values: 4.0 to 30.0 dB
8. The equipment shall have metal housing with “F” connections attached to steel backplate, sized to duplicate standard AC duplex outlet.

2.05 TERMINATORS AND CONNECTORS

A. These devices are used to terminate RG-11 and other cables. Terminators are applied to unused ports of tap offs, splitters, and combiners.

B. The technical specifications shall be as follows:
1. Connectors shall be “F” type with attached compression ring. Two cable types are used in the system.
a. RG-11 broadband-grade coax.
b. RG-6 broadband-grade coax.
2. The connectors shall have metal housing with “color chromate” clip plating.
3. The technical specifications for RG-6 cable connectors shall be as follows:
a. The device shall be male connector, attached compression ring, Type “F”.
b. The inside diameter shall be 0.342 inches.
4. The technical specifications for RG-11 cable connectors shall be as follows:
a. The device shall be a male, two-piece compression Type “F” connector.
b. The device shall have a center conductor into which the cable inner conductor connects.
c. Do not feed the cable inner conductor through the connector without the centerpiece pin.

2.06 INTERIOR DISTRIBUTION CABLE (RG-6)

A. This cable shall be used for interior connections in the building. Also to be used for all other internal purposes unless noted otherwise.

B. The technical specification shall be as listed below:
1. Impedance 75 ohm +/-2.0 ohm.
2. Insertion loss per 100 feet:
a. At 5 MHZ, 0.6 dB
b. At 108 MHZ, 1.95 dB
c. At 210 MHZ, 2.78 dB
d. At 300 MHZ, 3.29 dB
e. At 400 MHZ, 3.81 dB
f. At 550 MHZ, 4.49 dB
3. Cable shall be shield type, 100% foil wrap + 65% aluminum braid.

2.07 INTERIOR TRUNK CABLE (RG-11)

A. This cable may be used as the trunk cable between the MDF and various floor IDF closets.

B. The technical specifications shall be as follows:
1. Shield, foil +90 percent aluminum, nominal DCR 4.8 ohm per 1,000 feet.
2. Center conductor: copper

3. The loss shall be less than or equal to the following:
    a. At 5 MHZ, 0.38 dB
    b. At 108 MHZ, 1.85 dB
    c. At 300 MHZ, 2.20 dB
    d. At 400 MHZ, 2.56 dB
    e. At 550 MHZ, 3.03 dB

2.08 TRUNK AMPLIFIERS

A. This device is used to increase the signal level at the head-end to the necessary trunk level. An amplifier is used to drive each trunk branch. The amplifier must pass reverse channels. Supply Blonder Tongue BIDA 750-30, or approved equal, as required.

B. The technical specifications are given below:
    1. Bandwidth: 50 to 550 MHZ
    2. Full gain: 33 dB or 50 dB
    3. The equipment specifications shall be as follows:
        a. Flatness ± 0.75 dB.
        b. Gain control range: 15 dB.
        c. Slope control range: 10 dB.
        d. Input return loss: 14 dB.
        e. Output return loss: 14 dB.
        f. Noise figure: 7.0 dB.
        g. Output level: +44 dBmV.
        h. Composite triple beat:
            1) for 35 dB gain: -60 dB
            2) for 50 dB gain: -58 dB
        i. Cross modulation: -61 dB.
        j. Second order inter-modulation:
            1) for 33 dB gain: -72 dB
            2) for 50 dB gain: -74 dB
        k. Hum modulation: -61 dB.
        l. Input/output test point level: -30, ± 2 dB.
        m. Operating temperature: -20°C to 60°C.
        n. Number of hybrids: 2.
        o. Type of hybrids: push-pull.
        p. Connectors: “F” Type
        q. Provide plug-in attenuators as required.
    4. Power requirements: 117 volt AC, 60 Hz, 0.5 amps
    5. Dimensions: 19 inches wide by 1.75 inches high by 6 inches deep, maximum

C. Use the similar specification for reverse channels amplifier.

PART 3 - EXECUTION

3.01 GENERAL

A. The picture quality for the CATV drops in the buildings shall be TASO 1 or 2. The signal level at this point shall be between +0 and +15 dBmV.

B. The picture quality in the trunk system shall be TASO 1, and the signal level shall be at least 10 to 15 dBmV.

C. For the trunk CATV, no amplifier shall be installed outside the building.

D. The signal level on the trunk at any point shall not exceed +46 dBmV.

E. Provide grounding blocks for CATV cable where required by NEC.

F. Coordinate CATV system requirements with Owner's IT Department prior to purchasing equipment.

END OF SECTION

SECTION 28 0500
COMMON WORK RESULTS FOR SECURITY SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

B. Drawings and the following Specifications apply to work of this Section - SECURITY AND COMMUNICATION SYSTEMS SPECIFICATIONS- GENERAL REQUIREMENTS.
   1. Refer to all contract drawings and specifications listed in this Section 280500 for additional requirements.
   2. Construction Specification Sections:
      a. Section 28 0500 - Common Work Results for Security Systems
      b. Section 28 0510 - Special Requirements for Security Systems
      c. Section 28 0520 - Control Consoles, Cabinets and Enclosures
      d. Section 28 0530 - Operational Sequences for Security Systems
      e. Section 281300 - Security Access Control System
      f. Section 28 2300 - Video Surveillance Cameras
      g. Section 28 2313 - Video Surveillance Control and Management Systems
      h. Section 28 4000 - Security Control Systems
      i. Section 28 5000 - Intercom and Paging System
      j. Section 28 7000 Watch Tour System
   3. Contract Drawings:
      a. ES Series Drawings
      b. E Series Drawings

1.02 CODES, STANDARDS, AND REGULATIONS

A. All work of Division 28, and the works of the related sections shall comply with the latest codes, standards and regulations of the following:
   1. National Electric Code (NEC) – NFPA 70.
   2. National Fire Protection Association (NFPA).
   3. International Building Code (IBC).
   4. Underwriters' Laboratories (UL).
   5. National Electrical Manufacturers Association (NEMA).
   6. Instrument Society of America (ISA).
   7. Institute of Electrical & Electronic Engineers (IEEE).
   8. Federal, State and Local Ordinances.
   9. Federal Communications Commission (FCC) Regulations.
   10. Americans with Disabilities Act (ADA).
   11. Federal Communications Commission (FCC) Regulations.
   12. Telecommunication Industries Association (TIA).
   13. Electronic Industries Association (EIA)

1.03 SUMMARY OF PROVISIONS IN THIS SECTION

A. This Section includes:
   1. Requirements regarding qualifications of the contractor and all sub-contractors.
   2. Qualification requirements for all technical personnel of the said contractor and subcontractors assigned to this project.
   3. Submittal related to overall system of security and communications equipment proposed by the General Contractor.
   4. Coordination of the Security Systems work with the works of other trades.

5. Testing of the installed security and detection equipment.

1.04 DESCRIPTION OF WORK

A. All work described in Division 28 shall be performed by the Special Systems Contractor (SSC).

B. The contractual obligations for Security and Communication Systems Work shall refer to design, supply, installation, wiring, repair and maintenance of the electrical and electronic equipment, security, communications and safety systems, including labor and materials by the approved Contractor.

C. The Special Systems Contractor (SSC) shall provide all work described in Division 28 Specifications, work shown on Contract Drawings. The SSC shall be defined as the Contractor, all Sub-contractors, and manufacturer personnel providing work specified in Division 28. The Contractor shall refer to all Contract Drawings and Specifications for a complete definition of work required. The following is only a generalized summary of work required.
   1. Provide Conductors and Cables required for systems specified in Division 28 installed in conduits, raceways and infrastructure provided by the Division 26 Electrical Contractor. Coordinate with General Contractor and Electrical Contractor where applicable. Refer to the Contract Drawings and Division 26 for additional requirements. Refer to Specification Section 271000 for Structured Cabling requirements.
   2. Coordinate UPS backup power requirements with electrical contractor for all systems under this project. Refer to Specification Section 271000 for UPS specification.
   3. Provide all Electrical work including Special Backboxes and specialized junction boxes that are to be installed by the electrical contractor. Provide all security equipment wiring, power supplies, console receptacles, power distribution strips and connections.
   4. Provide Security Fasteners for installation of all devices. Provide tamper-proof fasteners in all areas exposed to the detainees.
   5. Provide Central Control Workstations and Equipment Enclosures at the Central Control Center for normal and emergency control of doors and gates in the path of egress/access, video surveillance monitoring and recording, intercom and paging, access control, and other miscellaneous systems such as telephone equipment associated; coordinate with Owner and to provide backup of all Local Control Consoles. Coordinate with with other trades for their installation and location of Fire Alarm Systems and Building Management Systems
   6. Provide Local Control Workstations and Equipment Enclosures at the Housing Unit locations for normal and emergency control of doors in the path of egress/access, video surveillance monitoring and recording, intercom and paging, access control, and other miscellaneous systems. All local control systems shall be networked to the Central Control Center and the PLC system.
   7. Provide Control Workstations and Equipment Enclsoures at the Booking and Medical locations for normal and emergency control of doors in the path of egress/access, video surveillance monitoring and recording, intercom and paging, access control, and other miscellaneous systems. All local control systems shall be networked to the Central Control Center and the PLC system.
   8. Provide server-grade computer system with computer Graphical User Interface, software, printers, communication devices and peripheral devices for control, monitoring, logging, printing, and archiving of all Security/Communication Systems and all necessary system and application programs, specified in Division 28 and outlined on the Contract Drawings.
   9. Provide Programmable Logic Control (PLC) System integrating all sub-systems including Door/Gate Control. Provide distinctive sound signals for each system. Provide interfacing with all electric doors, hardware, cardreaders, video system, Intercom Paging system, Duress Alarm and computer Graphical User Interface (GUI) screens. Provide interface for command, control, and takeover of Local Control systems from Central Control. Provide command, control, and takeover of PLC System.

10. Provide all door monitoring switches outlined on Contract Drawings. Wire and integrate all electric door locks and Door Position switches that are integral to the security doors. Provide all power supplies, relays and interfaces to the computer control system.
11. Provide Intercom and Paging System. Provide Master Intercom Stations at Central Control workstation location and Local Control workstation locations. Provide paging speakers with adapter transformers and cabling throughout the expansion. Provide Paging through Intercom stations amd Paging Speakers. Provide intercom stations at selected entry doors to the housing units, main corridor doors and all recreational areas and as outlined on the contract drawings. Provide cabling as required. Provide amplifiers and paging adapters. Provide integration with the control system's computer GUI screens.
12. Provide IP-based Video Surveillance System including interior and exterior cameras, lenses, monitors, network recorders, PTZ controller, video management server and software, fiber optic transceivers for all exterior cameras, patch panels, equipment racks, patch cables, miscellaneous mounting hardware, and interfacing to control system's touch screen GUI screens.
13. Provide all Access Control card readers, housings, adapters, cabling, backboxes and interfaces to the computer GUI Control System. Provide all necessary Access control database management software, reporting software and card generation and record management software.
14. Provide Watch Tour system to allow for guard watch tours of the facility. Refer to Contract Documents for locations.
15. Provide all door monitoring switches outlined on Contract Drawings. Wire and integrate all door electric door locks, latch monitors, and Door Position switches that are integral to the security doors. Provide all power supplies, relays and interfaces to the Touch Screen Control System.
16. Provide Wired Duress buttons as outlined in the contract documentation.
17. Provide complete integration of Security and Communications Systems as outlined within the Contract Documents.
18. Provide coordination, programming coordination and compliance with all County IT standards, system naming conventions and network security system architecture.
19. Provide outputs and GUI/PLC programming for controlling Utilities; this shall include Lighting, TV Power, and Power Outlet shut off. Coordinate interconnectivity of systems with other Trades.
20. Provide two (2) years on-site service warranty for all parts and labor. Provide Spare Parts/Service Contract – for equipment intended to be used after expiration of the warranty.
21. Provide training on all equipment and all training materials.
22. Provide single point grounding of all Security and Communication Systems Components and circuits provided under this Contract.
23. Coordinate all work with other contractors as necessary, including door installer, electrical and fire protection contractors, to insure a fully integrated functioning Security Control and Communications System.

1.05 SPECIAL SYSTEMS CONTRACTOR (SSC) QUALIFICATION REQUIREMENTS

A. Any Special Systems Contractor (SSC) shall submit qualification data for approval as part of the submittal process. Verbal approval will not satisfy this requirement. All SSC's shall submit a completed AIA 305 form and all information exactly as required. Grounds for disqualification shall exist if it is proven that the information submitted is inaccurate or, in the opinion of the Design Professional and Owner, does not satisfy the qualification requirements. If the submitted SSC is disqualified, the General Contractor shall submit an SSC firm meeting stated qualifications at no additional cost to the Owner.

B. The SSC, all sub-contractors and their technical personnel, performing SSC work shall have a minimum of five (5) years of proven experience in the installation and servicing of systems of similar size, complexity, and performance. The proven, relevant experience requirement shall apply to all personnel providing Systems work on this project. Relevant experience shall be defined as systems with similar complexity and integration requirements as the work required under this Contract. The Contractor shall submit system description, details and other information to demonstrate that they are qualified for this project. Submit qualification data, list of key personnel assigned to this project and references as specified in this section. The Design Professional and Owner shall have the opportunity to contact all contractor references and visit any of the referenced projects through arrangements and coordination provided by this contractor at no additional cost.

C. The SSC shall submit the following qualification data:
   1. Evidence that the organization and technical personnel assigned to this project have a minimum of 10 years experience in successfully completing projects of equal scope, quality, type and complexity to that required herein. Include resume(s) of personnel providing work for this project, with description of responsibilities on this project and referenced projects.
   2. List of at least three (3) comparable correctional/detention projects, completed within the last 10 years, on which min. 80% of Security Systems work has been performed directly by the SSC technical personnel that have been operational for a min. of three (3) years. Include for each facility the following:
      a. Name and location of Project.
      b. Name, address and telephone number of the Design Professional.
      c. Name, address and telephone number of the Owner.
      d. Name, address and telephone number of General Contractor and Project Manager.
      e. Name, address and telephone number of SSC's Bonding Company for the individual project.
      f. Date of Occupancy.
      g. Contract Values: Entire Project and SSC's portion.
      h. Type and size of systems provided.
   3. The Contractors shall provide all detailed information requested during review and qualification process promptly to allow complete evaluation of contractor's qualifications, quality of work and warranty services provided for the referenced projects.
   4. The Contractors shall be responsible for site visits to referenced projects.

D. All SSC’s shall be qualified and be responsible for directly performing the Security and Control Systems work, shown on contract documents.

E. The SCC’s installers shall have manufacturer’s training on all systems being provided. If required, the Contractor shall provide on-site assistance of manufacturer’s representative to aid in any installation or troubleshooting problems.

F. All equipment and materials provided shall be new and without blemish or defect. All equipment shall bear labels attesting to Underwriters Laboratories listing where subject to Underwriters Laboratories label service (UL file numbers shall be available for all UL listed products upon request to substantiate the listing). All manufacturers of equipment and materials pertinent to these items shall have been engaged in the manufacture of said equipment a minimum of five (5) years unless stated otherwise in these specifications.

G. Each major component of equipment shall have the manufacturer's name, address, model number, and rating on a plate securely affixed in a conspicuous place. The nameplate of a distributing agent will not be acceptable. NEMA Code Ratings, UL label, or other data which is die-stamped into the surface of the equipment shall be stamped in a location easily visible. Performance as delineated in schedules and in the specifications shall be interpreted as

minimum performance.

1.06 PERSONNEL REQUIREMENTS

A. The following personnel shall be assigned to the project with resumes submitted with technical proposal:
   1. Principal-in-Charge with QA/QC responsibility.
   2. Project Manager with QA/QC responsibility.
   3. Project Engineer with Network Certification, 5 years experience and Design responsibility with formal Electronics training and Operations knowledge and/or Certified Electronic Technician (CET) with Network Certification and 5 years experience.
   4. Field Technician with 5 years experience and certifications in the installed products.
   5. Programmer(s) with certifications for all software and manufacturers the Contractor will be provided for the project.

B. Network certifications shall consist of MCSE, CCNP, and/or TIA certification as a minimum.

1.07 RELATED WORK

A. Related work includes, but is not limited to, the following:
   1. Miscellaneous steel and hangers required for the support of electrical equipment.
   2. Equipment identification as specified herein and elsewhere.
   3. Assembly of equipment furnished disassembled.
   4. Cleaning of all apparatus specified elsewhere.

B. Where the SSC is required to install items furnished by the Owner, they shall include for such items:
   1. The coordination of their delivery.
   2. Their safe handling and field storage to the time of final acceptance in the project.
   3. The correction of any damage, defacement or corrosion to which they may have been subjected.
   4. Their field assembly and internal connection as may be necessary for their proper operation.
   5. Their mounting in place including the purchase and installation of all dunnage, supporting members, and fastening necessary to adapt them to architectural and structural conditions.
   6. Their connection to systems specified, including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

1.08 DEFINITIONS AND APPLICABILITY TO DIVISION 28 SECURITY AND COMMUNICATION SYSTEMS WORK

A. The definitions of this section are intended to preserve and expand the applicability of definitions of the General Conditions for all Contract Documents. These definitions are intended to add requirements applicable to Division 28 Special Systems Work. Refer to Division 28, Security and Communication System Specifications and Contract Drawings for additional requirements.

B. The following additional definitions shall apply to all Special Systems work:
   1. “PROVIDE” shall mean that this contractor shall furnish, install, test, adjust, start-up, program, interface and service all devices required for complete and operational Security Systems.
   2. “INTEGRATION” shall mean that this Contractor shall provide all systems interfacing and programming necessary to physically and logically connect multiple systems through hardware, software and project specific programming.
   3. “PROVIDE CABLING” shall mean that this Contractor shall provide cabling, raceways, concrete encased conduits, and rigid or EMT conduits as specified for each type of location. Comply with requirements of Division 26 for acceptable conduit types.

4. “RESPONSIBILITY OF THIS CONTRACTOR” shall mean the work shall be performed by the SSC subcontractor under the overall direction and supervision of the Prime Contractor having a contract directly with the Agency.
5. “New” shall mean unused and currently manufactured within one (1) year.

1.09 INTERPRETATION OF CONTRACT DOCUMENTS

A. This section of the specifications and related drawings describe general provisions applicable to every section of Division 28.

B. No exclusions from, or limitations in, the language used in the drawings or specifications shall be interpreted as meaning that the appurtenance or accessories necessary to complete any required system or item of equipment are to be omitted. The Architect & Design Professional’s interpretation of Contract Documents for minimum performance requirements shall be binding to the Contracts.

C. The drawings utilize symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installations. The work shall be installed, in accordance with the intent diagrammatically expressed on the drawings, and in conformity with the dimensions indicated on final architectural and structural contract drawings and on equipment shop drawings. No interpretation shall be made from the limitation of symbols and diagrams that any elements necessary for complete work are excluded.

D. Certain details appear on the drawings that are specific with regard to the dimensioning and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work.

E. Information as to the general arrangement of construction shall be derived from architectural and structural drawings and specifications only.

F. The use of words in the singular shall not be considered as limited where other indications denote that more than one item is referred to.

G. The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions of detail drawings. For exact locations of building elements, refer to dimensioned drawings; however, field measurements take precedence over dimensioned drawings. Report to the Architect & Design Professional any discrepancies discovered between security drawings and the drawings for other divisions of work.

H. The Contract Division and Specifications are complementary; what is shown and required on one document shall be provided as if shown and required by all documents.

I. Provide all materials for systems, resulting upon completion, in functioning systems in compliance with performance requirements specified. The omission of express reference to any parts necessary for, or reasonably incidental to, a complete installation shall not be construed as a release from furnishing such parts.

J. Any deviations from the wiring shown due to a particular manufacturer's requirements shall be made at no additional cost to the Owner. Changes in electrical service to equipment due to substitutions of equipment by any contractors shall be at the cost of that contractor.

1.10 WARRANTY

A. All work shall be guaranteed to be free from defects. Any defective materials or workmanship, as well as damage to the work of all other Trades resulting from same, shall be replaced or repaired as directed by the Owner's representative.

B. The SSC shall provide to the Owner a written guarantee that the installation, including controls and all other equipment covered under each section of the specifications, performs in an efficient and satisfactory manner.

C. The SSC shall warranty all phases of the system (including, but not limited to, software, hardware, peripheral equipment) for a period of two (2) years from the date of written final acceptance against defective materials, design and workmanship. The SSC shall include all preventive maintenance, parts, and servicing required for the systems provided under Division 28 to be continuously operational. The SSC shall provide all preventive maintenance work necessary to maintain the systems in continuous operation through the warranty period. The SSC shall provide all parts required for warranty service, in addition to any spare parts specified in other specification Sections which are intended to be used by the Owner for non-warranty servicing. Upon receipt of notice from the Owner of failure of any part of the warranted system, the SSC, with the assistance of the supplier, shall promptly replace or repair the defective component to restore an acceptable system at no cost to the Owner.

D. The warranty period shall commence upon signed final acceptance by the Owner. Acceptance tests and procedures shall be developed by the SSC and accepted by the Architect & Design Professional/Owner.

E. During the warranty period, there shall be no charges to the Owner for service calls including mileage, labor, travel, expense, etc. for warranty work. The SSC shall submit itemized warranty costs for each year. The costs associated with warranties provided by the SSC shall not be paid to the SSC with the construction costs. The Owner shall pay for satisfactory warranty servicing semi-annually after completion of each semi-annual service period. The SSC shall submit costs and documentation required for Owner's budget planning and contract management.

F. Maintenance and Service:
   1. This service shall consist of supplier's factory trained representative providing the following:
      a. Personnel factory trained by the manufacturers of the system's components.
      b. Authorized representative of the manufacturer and have an agreement of factory support.
      c. Provide on-site inventory of spare parts to support the "Systems Response Requirement" listed below. Spare parts to be stored at the facility. Spare parts shall remain the property of the Owner after expiration of the manufacturer's service period.
      d. Five (5) years experience minimum servicing systems of the type included in this project.
      e. Capability of making additions or changes to the software systems used in this project.
      f. Capability of servicing the individual system components and the total integrated system.
      g. All test equipment.

G. Service Requirements - Guarantee service response requirements shall include the following:
   1. 24-hour telephone number.
   2. Service organization shall have a site response time of not more than four (4) hours and be able to restore the system to service within eight (8) hours after being notified. This service shall be on a 24-hour per day basis every day of the year, including weekends and holidays.
   3. Shall maintain current set of system documentation including but not limited to the following:
      a. Wiring diagrams, system diagrams and schematics.
      b. Operation and maintenance manuals.
      c. Software programs with flow charts or other appropriate troubleshooting documentation.

d. Other documentation as required to provide assistance to the Owner's qualified technical representative on the operation and maintenance of the systems.
e. All documents shall be made available to the Owner upon request.
f. Upon termination of maintenance agreement, all system documents, or copies of such, shall be furnished to the Owner for maintenance continuity.

H. Provide technical personnel and spare parts conveniently located, to ensure that the Mean Time to Service/Repair (MTTS), of any malfunction/system failure to be maximum eight (8) hours. MTTS shall be defined as the required time to return the malfunctioning system to normal operations, calculated for any three-month period.

I. Provide the Inspection and Preventive Maintenance Service specified below with each year of the warranty period:
1. Two (2) routine inspections/year. The Contractor shall provide an inspection plan which ensures that all system components are inspected, adjusted and reconditioned or replaced if necessary at least one (1) time/year.
2. The Contractor shall provide an emergency service plan which guarantees that the systems provided under this contract are completely functional within 24 hours from the time the Owner have placed the service call.
3. The Inspection shall include all parts and labor.
4. The SCP shall include telephone number, name and address of company, department, manager and service personnel assigned for servicing the systems provided under this contract.
5. The Inspection and Preventive Maintenance program shall include the total cost of all services included, terms and conditions of payment.
6. Provide minor changes to software, Graphical User Interface screens and PLC to accommodate the Owner changes required for operations, e.g., changes such as icon locations and coloring, room names and numbers, interlocking, reports and printouts. These change periods shall be coordinated with the Owner during the first year of operations.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. When the SSC substitutes equipment manufactured by a vendor other than the specified manufacturer, the Contractor shall be responsible for the operation of the product in the intended system, including all related costs required to make the design work, function, and fit in the allocated space. The Contractor shall submit all substitutions to the Design Professional for approval within 15 days from Notice-To-Proceed (NTP).

B. Refer to Division 01 and 28 for Product Options and Substitutions.

C. All substitutions shall meet the performance requirements specified at a lower cost to the Owner than the products specified.

D. The SSC shall submit all data necessary to prove that the substitute products meet the performance requirements shown on the Contract Documents.

E. The SSC shall submit all requests for substitutions to identify the following:
1. Specification section, paragraph, model and manufacturer of the product specified.
2. Suggested substitute including model and manufacturer and each component required, including quantities.
3. Credit to the Owner.
4. Complete product data, including cut sheets, manufacturer specifications, application diagrams and installation details.
5. Description of the reason why, in the SSC's opinion, substitution is recommended. Description and details for installation of the substitute product as specifically required for

this project.

6. Technical description of equivalent performance and any deficiencies.

2.02 MANUFACTURED PRODUCTS

A. Materials and equipment provided shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

B. When more than one unit of the same type of equipment or material is required, such units shall be the products of a single manufacturer.

C. Equipment Assemblies and Components:

1. All components of an assembled unit need not be products of the same manufacturer; however, all components must be acceptable to the Design Professional and Contracting Officer.
2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
3. Components shall be compatible with each other and with the total assembly for the intended service.
4. Constituent parts which are similar shall be the product of a single manufacturer.
5. Moving parts of any element of equipment of the unit normally requiring lubrication, shall have means provided for such lubrication, and shall be adequately lubricated at the factory prior to delivery.

D. All factory and field wiring shall be identified on the equipment being furnished and on all wiring diagrams.

2.03 EQUIPMENT IDENTIFICATION

A. In addition to the requirements of the National Electrical Code, install an identification sign which will clearly indicate information required for use and maintenance of items such as cabinets, control devices and other significant equipment except in areas directly accessible to inmates.

B. Nameplates shall be laminated white phenolic resin with a black core and engraved lettering, a minimum of 1/4-inch high. Nameplates that are furnished by manufacturer, as a standard catalog item, or where other methods of identification are herein specified, are exceptions. Affix with rivets or other approved fasteners. Glue, tape or cement is not approved.

C. Upper case letters of uniform height; centered on device, coverplate, or enclosure; engraved letters filled with a contrasting color; and all characters made clearly and distinctly.

D. Use abbreviations defined in the contract documents whenever possible. Use plan designations for labeling unless indicated otherwise.

E. Refer to Section 280510 for cable labeling requirements.

PART 3 EXECUTION

3.01 INSPECTION AND PREPARATION OF WORK

A. Prior to any work, the SSC shall carefully inspect the installed work of all other trades and verify that all such work is complete to the point where his installation may properly commence.

B. Verify and certify to the Architect & Design Professional/Owner that all equipment may be installed in accordance with all pertinent codes and regulations, the contract drawings and specifications and the referenced standards.

C. Return to original condition any paved areas, sidewalks, planting, etc., disturbed during system installation.

3.02 INSTALLATION

A. Install all equipment in accordance with the manufacturer's recommendation.

B. Secure equipment-using fasteners suitable for the use, materials, and loads encountered. All hardware shall be tamperproof. Submit evidence-providing suitability. Do not attach electrical materials to roof decking, removable or knockout panels, or temporary walls and partitions, unless indicated otherwise.

C. Equipment location shall be as close as possible to locations shown on contract drawings. Coordinate locations of devices with other trades. The SSC shall provide wall, console, furniture, millwork mounted or ceiling mounted devices as directed by the Architect & Design Professional with no additional cost to the Owner.

D. Working spaces shall be at minimum as specified in the National Electrical Code for all voltage specified, but not less than 3 feet.

E. All equipment shall be installed in location and manner that will allow for convenient access for maintenance and inspection.

F. Coordinate location of equipment and conduit with other trades to minimize interference.

G. Routing shall be laid out in advance. The SSC Contractor shall develop detailed coordination drawings to identify use of chases, spaces above ceiling and Mechanical / Electrical / Security / Electronic Rooms. The General Contractor shall be advised prior to drilling through structural sections, for determination of proper layout. Routing shall be located so as not to affect structural sections such ribs or beams.

H. Where conduits, wireways, and other raceways pass through fire partitions, fire walls or walls and floors, install a firestop that provides an effective barrier against the spread of fire, smoke and gases. Firestop material shall be packed tight, and completely fill clearances between raceways and openings. Firestop material shall be in accordance with reference codes standards, regulations, and contract documents.
   1. Floor, exterior wall and roof seals shall be watertight. Walls and floors that are cored for installation of conduit shall be sleeved with steel tubing, grouted and the space between the conduit and sleeve filled as required by Codes and Standards.
   2. Tubing shall extend minimum one (1) inch above finished floor.

I. Hangers and other supports shall support only equipment and materials. Provide not less than a safety factor of 5, which shall conform with any specific requirements as shown on the drawings or in the specifications. In areas inside the institution fence, exposed equipment and materials, including screws and other fasteners, shall be tamperproof. Cover plates shall have beveled edges. Coordinate with Owner, and provide work that meets the security hardware and installation standards established for the institution.

J. Protect all materials and equipment from damage during storage at the Site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage.

K. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on all sides with securely fastened protective rigid of flexible waterproof coverings.

L. Conduits shall be protected by storing it on elevated supports and capping the ends with suitable closure material to prevent dirt accumulation in the piping.

M. During construction, cap the top of all conduits and raceway installed vertically.

N. During installation, equipment shall be protected against entry of foreign matter on the inside; and be vacuum cleaned both inside and outside before testing, operating and painting. Provide painting selected by the Architect & Design Professional.

O. Damaged equipment, as determined by the Architect & Design Professional/Owner, shall be repaired or replaced and returned to operating condition.

P. Painted surfaces shall be protected at all times and protection removed prior to final inspection.

Q. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.

R. Perform work as required, indicated, and in compliance with site work. Provide excavation, trenching, backfilling, compacting and resurfacing. Provide seeding and soil stabilization around the entire site, through the perimeter security zones as required for maximum 1% false alarm rate per month, for all systems.

3.03 ADJUSTING, TESTING AND CLEANING

A. Substantial Completion requirements are as follows:
   1. All systems shall be completed and operational, and all controls shall be set and calibrated at SUBSTANTIAL COMPLETION.
   2. All testing, start-up and cleaning work shall be complete at SUBSTANTIAL COMPLETION.
   3. All requested modifications to software, Graphical User Interfaces, CCTV, intercom/paging and duress system have been completed.

B. All bright metal or plated work shall be thoroughly polished. All temporarily pasted labels (except warning/ID labels), dirt and stains shall be removed from the devices.

3.04 SYSTEMS CERTIFICATION

A. The Contractor shall be responsible for Total Quality Control Management for all work provided. Provide certification of the following in regards to the systems:
   1. The SSC shall inspect, test and adjust systems as required to meet the operational, performance and reliability requirements. When all systems are operating as specified, the Contractor shall schedule and organize joint testing with Architect & Design Professional and Owner.
   2. The SSC shall provide joint testing and certification with the Owner designated inspection firm, Local Authorities Having Jurisdiction and Architect & Design Professional.
   3. The SSC shall submit complete Certifications and test results. Refer to Certification Forms included with the Contract Documents.
   4. The Contractor shall provide a separate certification for each system.
   5. The system certification shall attest that the system provided meets the operational criteria established by the Contract Documents and the requirement of codes, standards and regulations applicable for the system.
   6. A manufacturer's representative shall be present during each System Testing and Certification.

B. After all final tests and adjustments have been completed and approved by the Architect & Design Professional/Owner, a competent employee of the SSC shall be provided to instruct the Owner's Representative in all details of operation and maintenance for equipment installed. Make available as required, qualified personnel to assist in operations of all equipment for a period of 30 days to assure that Owner's Representatives are qualified to take over operation and maintenance procedures. This Contractor operation period shall be provided on dates specified by the Owner. Instruction periods shall be as designated by the Owner and shall not necessarily be consecutive. Manufacturer's representative shall conduct training on specialized electronic systems as described in Division 28.

C. The SSC Contractor shall submit separate recommended INSPECTION, TESTING AND PREVENTIVE MAINTENANCE PROCEDURES for each system.

3.05 CLOSEOUT- SOFTWARE AND ARTWORK SAFEKEEPING

A. At SUBSTANTIAL COMPLETION, and min. 4 weeks before FINAL ACCEPTANCE, the SSC shall deliver to the Owner, under signature, the following Software and Original Artwork:
   1. All Standard Operating/Application Software Source Code used for this project.

2. All Custom Operating/Application Software Source Code and required compilers specifically developed for this project.
3. All Diagnostic Software Source Code and Reporting facilities.
4. All Systems Databases.
5. All Original Artwork for Control Consoles and Graphic Control Panels in AutoCAD file format and film format.
6. Hard copy of all software and artwork delivered as described above.
7. User Instruction Manuals for all software and systems.
8. One (1) spare, ready to use touchscreen monitor for the Control Console.

B. At final acceptance, the SSC shall deliver AS-BUILT/RECORD drawings and details.

C. Software Source Code shall be locked up in a Security Fireproof Safe by the Owner to ensure capability for the Owner to continue operation for minimum 10 years. Source Code shall not be divulged or copied for any other reason.

END OF SECTION

SECTION 28 0510
SPECIAL REQUIREMENTS FOR SECURITY SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

B. Refer to all contract drawings and specifications listed in Section 28 0500 for additional requirements.

1.02 QUALITY ASSURANCE

A. All materials and equipment shall be new unless specifically stated otherwise. The specifications establish the standards of quality required, either by description or by references to brand name manufacturers.

B. Where one product only is mentioned by name, the Contractor shall base his bid on the use of the name product.

C. When the equipment is relocated to a place other than that shown on Contract Drawings, or when equipment other than that specified is used, the Contractor shall pay the extra cost of required revisions such as structural steel, concrete, electrical, piping, etc.

1.03 SUBMITTALS

A. Submit all schedules, test plans and procedures, training materials, spare parts lists and requested samples. Submit certification and Warranty Documents. Submit Operation, Maintenance and Programming Manuals. Submit shop drawings, product data, bill of materials, riser diagrams, details and point-to-point wiring diagrams. Submit all documents as outlined in the various Division 28 specifications.

B. Refer to Table 280510-1 and specific submittals listed in any Division 28 Section.

1.04 PRODUCT DATA AND SYSTEM RECORD MANUAL

A. Product Data Manual shall include manufacturers' cut sheets for products used for this Project. Divide the manual to include a separate chapter or volume for each specification listed in Division 28.

B. System Record Manual shall include as-built / final information and data for the products used for the Project. Structure this manual similar to the Product Data Manual including separate chapters for Spare Parts and Equivalent Products.

1.05 SHOP AND SYSTEM RECORD DRAWINGS

A. Submit the product data manual together with the shop drawings as required by the project schedule. Shop drawings shall be provided no later than 60 days after Notice to Proceed.

B. The Shop Drawings shall be created and produced by the Contractor using AutoCAD or similar industry-standard computer aided drafting (CAD) program. Submissions using scanned or copied portions of the Contract Documents shall be rejected without review. The Contractor shall be permitted to utilize the blank Architectural AutoCAD floor plans and ceiling plans if they are released by the Architect for such purposes.

C. The Shop Drawings shall be produced through a coordinated effort among all trades and shall show required coordination details. Refer to specifications section 28 0500 for additional details and requirements for coordination with other trades. The Contractor shall be responsible for any associated costs or delays caused by failure to perform the necessary coordination.

D. Reference Contract Document identifications for Specifications and Drawings.

E. In addition to the technical proposal submittal requirement of the General Requirements for Security Systems, all work shall be based on approved Shop Drawings and referenced product data.

F. The Shop Drawings shall include items and references listed as follows:
   1. A drawing index listing each drawing number and title.
   2. A symbols and abbreviations sheet defining each symbol and abbreviation used in the shop drawing set. Do not include symbols or abbreviations which will not be used for this project.
   3. A master cabling schedule listing manufacturer, model, and brief description for each cable type used in this project.
   4. Cable labeling and color coding schemes definitions.
   5. Floor plans and ceiling plans showing each: field device, equipment room, control room, control jurisdiction, and major cable path.
      a. All field devices shall be shown in their coordinated, dimensioned, intended location. If the typical field device will be provided as per typical installation details, a reference to the associated installation details drawing shall satisfy the dimension requirement.
      b. Each field device shall be labeled with a unique identifier that indicates the device type and any unique properties, the location of the field device, and the associated equipment room. These unique identifiers shall be used across all drawing types (floor plans, diagrams, details, schedules).
      c. Each equipment room and control room shall be called out with a reference to a larger scale detail plan - refer to requirements below for details.
      d. Each major cabling path shall be represented. Include indication of the quantities and types of cables that shall use each main path. Indicate cable support type and penetrations where applicable.
   6. Point to point diagrams indicating the required equipment, cabling, and cable labeling.
      a. Each and every device and piece of equipment shall be individually represented on the single line diagrams - diagrams showing only “typical” connectivity shall not be accepted.
      b. Lines with appropriate cable/wire label annotations shall be used to show all required connectivity between all devices and pieces of equipment.
      c. Devices and equipment shall be neatly grouped according to their physical location. For example, all equipment within the main equipment room shall be shown inside of a rectangle labeled to indicate that it represents the main equipment room.
      d. All devices, cables, equipment, enclosures, and rooms shall be clearly labeled.
   7. Equipment and termination wiring details including indication of the type of termination for each cable, conductor, and cable shield. Diagrams/details showing termination details which are typical for many similar instances shall be acceptable.
   8. Single point grounding diagrams and details indicating ground bus bars, ground lugs, conductors, panels, and grounding rods as applicable.
   9. Installation details for each typical device and piece of equipment including dimensions in reference to site and building elements, references for material type, color, and aesthetic integration as required. Include mounts, fasteners, hardware, supports, and sealing as applicable.
   10. Control room and equipment room plan layout/configuration details including dimensions, details, and references for color and aesthetic integration. Indicate all equipment, enclosures, consoles, desks, racks, clearances, wireways, cable supports, and penetrations as applicable.
   11. All installation details shall reflect ADA requirements regarding height, type of function, accessibility, and other applicable ADA guidelines. As part of the close-out documents,

the Contractor shall provide a statement that it has complied with ADA requirements.

12. Calculations, graphs, and tables to show and substantiate required quantities, capacities, runtimes, loads, and similar.

1.06 DEMONSTRATION - HARDWARE AND SOFTWARE

A. No later than 120 days after receipt of the Notice to Proceed (NTP), and after the approval of the product data and shop drawings, the SSC shall demonstrate the operation of the Control and Processing hardware and software portion of Security and Communication Systems. The demonstration shall be completed to the satisfaction of the Design Professional/Owner.

B. The demonstration shall include at least one input as if received from each of the systems specified, and prompt operator input data to accomplish the proper sequence of operations as indicated in this Section and the Description of Operation for each individual control center and officer station. Provide enhancement of software and/or hardware which performs unsuccessfully or does not meet the requirements specified.

C. After all corrections have been made, the SSC shall notify the Design Professional who will recheck the systems for compliance of all items listed.

D. Submit demonstration procedure for review 30 days prior to the demonstration. Changes as desired by the Design Professional/Owner shall be incorporated into the demonstration procedures prior to the demonstration. If the Contractor elects to provide the demonstration at a location other than the project site, the SSC shall provide travel and accommodations to two (2) Agency personnel, two (2) Owners' Representatives and two (2) Design Professionals for each review period.

E. Demonstration shall show complete integration of at least one working component of each type of outboard system.

1.07 AS-BUILT DRAWINGS

A. The Contractor shall keep his on-site blueprints up to date at all times. All wiring shall be marked and indexed for permanent record and submitted with as-builts.

B. When field work has been completed, and before final inspection, deliver to the Owner’s Representative a complete set of prints, marked in colored marker, to show all changes made in the drawings so as to indicate the work as-built. Include dimensions from reference points for any concealed work (junction boxes, etc.) requiring future access.

C. The Contractor shall provide the Design Professional with the as-built drawings in electronic BIM/Revit format. The electronic BIM/Revit format of the as-built drawings shall provide the same information as provided on the complete set of paper as-built drawings. The BIM/Revit files shall also include individual device information to include manufacturer and model number for each device associated with each device.

D. Submit for Owner records the software artwork listed below.

1. Original software and software descriptions and manuals for all Security and Communication Systems.
2. Complete software database and database printout for all special systems software and database as of date of acceptance of the Special Systems by the Contracting Officer as applicable. All software shall be labeled with manufacturer's name and software version number. All custom software shall be appropriately labeled. All software shall be accompanied by a user's manual. A complete database printout shall be attached to the user's manual.
3. AutoCAD/BIM/Revit files of all artwork, touch control graphics, and all other graphics used on this project.

E. Spare Parts Manual - Submit spare parts manual containing list of recommended spare parts, equipment and materials, including firmware, software and memory chips. The spare parts list

shall include all parts that can render a system in one or multiple buildings inoperable as described in Division 28 Specifications and any parts that are not in the service organization's inventory and cannot be delivered to the site within 24 hours. For each item listed, provide the information listed below.

1. Manufacturer's name, address, phone number.
2. Manufacturer's model, series, version and GSA number, as applicable.
3. Mean time before/between failure (MTBF).
4. Number of devices of same type used for this project and number of spare parts recommended to be stored on the site.
5. Current approximate delivery time.
6. Current list price.
7. Product data and description of operation, including list of equivalent parts, if applicable.

F. The System Record Drawings shall include all as-built conditions and information pertinent to this project in AutoCad format

1.08 SERVICE AND TECHNICAL ASSISTANCE SCHEDULE

A. Provide a system servicing schedule shall include the information described below:
   1. Typical System Failures: Information that must be known by Owner’s system operating personnel before calling for services. Provide service log for recording all date and time of service calls, type of failure, description of the repairs, time to repair and service person’s name and telephone, date, time when the system was returned to normal operation.
   2. Service and Technical Assistance personnel and phone numbers schedule. The personnel, department representatives shall be those normally assigned by the contractor/system servicing company for the type and size of the systems installed under this project.

1.09 ADJUSTING OF SYSTEMS

A. All system components shall be adjusted for optimum performance under the local conditions particular to the project.

1.10 TEST PROCEDURES MANUAL

A. Submit for review and approval a System Test Procedure Manual for each system to include the data listed below:
   1. Test procedures for partial and total system testing.
   2. System adjustment schedule to include all system components that require adjusting.
   3. Typical Test Record Forms which will be used for recording test results. Cabling test record forms shall identify each cable consistent with the cabling schedules required.

1.11 TEST RECORD MANUAL

A. Submit a System Test Record Manual for each system to include the actual measurement data, as listed below:
   1. Approved test procedures.
   2. System adjustment schedule.
   3. Test records with actual test results, recorded on approved Test Report Forms.
   4. List of test equipment used.
   5. List of typical test conditions.
   6. Date and time of testing.
   7. Name and telephone number of the organization and person who performed the testing.

1.12 SITE TESTS

A. Include partial, work phase and end-to-end testing necessary to verify and record on approved Test Report Forms the compliance with applicable codes, standards, regulations, manufacturer specifications and Contract Documents.

B. As a minimum, the site tests shall include:
   1. Testing of all assemblies.
   2. Testing of individual equipment for each function.
   3. Testing of all cabling for shorts, opening, grounding and visual inspection for physical damage and labeling.
   4. Testing of all inputs and outputs and functions.
   5. Testing of all system configuration available by programming, switching or adjusting.

1.13 SYSTEM ACCEPTANCE

A. Schedule THE FINAL ACCEPTANCE TESTS with the Owner at a mutually agreed time. Contractor shall notify the Owner a minimum of 2 weeks in advance of the intended final acceptance time.

B. Should any part of a system fail during the acceptance tests to perform according to the Contract Documents the entire system shall be retested at an Owner selected time and date.

C. Correct deficiencies unacceptable to the Owner and provide a complete and functional system.

D. Record and submit to the Owner the final test results as specified herein.

E. Acceptance: Systems will not be accepted by the Owner until deficiencies have been corrected.

F. Beneficial use of systems by Owner will not be considered as an acceptance.

1.14 TRAINING

A. Provide training of Owner's selected representatives for operation, maintenance and programming.

B. Operation and Maintenance, Programming Manuals: Provide a copy of Operation Manuals, Programming Manuals and Maintenance Manuals to each of the participants to the training. Minimum eight (8) sets of manuals are required. Provide computer files with the contents of the training manuals.

C. Training sessions shall contain all information necessary for correct and effective operation, maintenance, testing, adjusting and programming of each system component.

D. Effective Training Periods. Preparation, set-up and testing times shall be included in addition to the minimum training sessions.

E. Typical training sessions shall be 2 hours for operation and 2 hours for programming. See Training Schedule in this Section for the number of sessions to be provided.

F. Provide typical one page flow charts for operation, testing, programming and troubleshooting in a format that is ready for framing.

1.15 TRAINING FOR SYSTEM OPERATION

A. Relate the operation training to the contents of the Operation Manuals, described herein.

B. Operation and Maintenance Manuals shall contain:
   1. Sequences of operation shown on actual graphic representation of the signals and controls provided.
   2. Operation Flow Charts (OFC) and descriptions.
   3. List of information the System Operator have to gather and log in the service log, before calling for service or technical assistance.
   4. List of contractor and manufacturers authorized service and technical assistance representatives, their telephone numbers and normal business schedule.

1.16 TRAINING FOR PROGRAMMING

A. Relate the contents of the training sessions for programming to the contents of the Programming Manuals. Provide minimum eight (8) Programming Manuals for the systems listed.

B. The Programming Manuals shall include:
   1. Control Consoles, Officer Stations, Graphics Panels, and Master Stations, typical task oriented flow charts. As a minimum the following tasks are required: data entry, configuration, review, report generation, diagnostics, start-up.
   2. Program troubleshooting flow charts.
   3. List of information the system programmer is required to document before service or technical assistance calls.
   4. List of contractor and manufacturer authorized service and technical assistance representatives, their telephone numbers and normal business schedule.
   5. List of Firmware and Software versions available for the system provided for this Project, description of the various characteristics of the firmware and software in terms of benefits to the end user.
   6. System upgrading characteristics and relocation information including hardware implications.

1.17 TRAINING FOR SYSTEM MAINTENANCE

A. Relate the maintenance training to the contents of the Operation and Maintenance Manuals, described herein.

B. Operation and Maintenance Manuals shall contain:
   1. Testing and Adjusting Flow Charts, and descriptions.
   2. Troubleshooting Flow Charts, and descriptions.
   3. List of information the System Operator has to gather and enter in the service log, before calling for service or technical assistance.
   4. List of contractor and manufacturers authorized service and technical assistance representatives, their telephone numbers and normal business schedule.
   5. Spare parts schedule, with recommended spare parts list for the type, size and complexity of the system provided under this project.
   6. Product data.
   7. System Record Drawings.

1.18 TRAINING VIDEO DVDS

A. Provide Training Video DVDs in standard format. Provide digital video files in AVI format for all training videos. Provide separate video DVDs with all training required for operation, programming and maintenance of the systems provided under this contract. The training DVDs shall closely follow the content of the training manuals and the on-site training provided. The video training DVDs shall include titling for each operation, programming and maintenance function. Contractor shall ensure that the video recording equipment is synchronized with all project video sources to avoid shadowing and blanking. At the minimum the training video DVDs shall include the information listed below:
   1. The Operation video training DVDs shall include all relevant information for operation of all devices provided. The training shall address interpretation of each signal, required operator actions, the sequence of operator actions, all operator follow up and reporting functions shown on graphical user's guide. Provide detailed demonstration of back-up, restoral procedures, emergency operations including power failures, partial and system failures. Refer to Operator Manual specifications, for additional requirements.
   2. The Programming video training DVDs shall include all relevant information for programming of all devices provided. Provide interpretation of error messages and

required debugging. Refer to Programming Manual specifications for additional requirements.

3. The Maintenance video training DVDs shall include testing, diagnostics, interpretation of results and inspection procedures. Provide detailed preventive maintenance procedures demonstrated through visual inspection, testing, cleaning, replacement and reconditioning of parts.

1.19 SPECIAL TOOLS, EQUIPMENT AND MATERIALS

A. Deliver to the Owners representative all special tools, equipment and materials necessary to maintain the system provided under this Contract. A list of all special tools, equipment and materials associated with each system shall be submitted to the Owner minimum 2 weeks prior to final acceptance test.

B. All electrical work documented on drawings or required under the fencing specifications shall be provided in its entirety.

C. Electrical specifications appearing in other Divisions of this set of Contract Documents shall be considered a part of this specification and shall be enforced as if fully described within these special requirements. The specifications for materials and installation of electrical/electronic components specified within Division 02 and Division 13 shall supersede those of any other section.

Submittal Registers on following pages.

1.20 TABLE 28 0510-1 - SUBMITTAL REGISTER

A. The Contractor shall submit coordinated drawings, manuals and test results for "EACH" system specified under Division 28. Refer to individual system specification sections. Submittal register to include submittals for electric power calculations, emergency power distribution and UPS power distribution schedules. All submittals shall be stamped-approved by Contractor, signed and dated prior to review. Unsigned materials shall be returned for such approval.

		Submit For			
Specification Sections	Description	Review	Approval by Owner &/or Design Professional	Records	Comments/ Reference Sections
Applies for Division 28	Detention Equip. & Special Systems Qualifications Performance Bonds	X	X	X	
	Product Data	X	X		
	Shop Drawings	X	X		
	Demonstration Procedures	X	X		
	Demonstration	X	X		
	Test Procedures Manual	X	X		
	Test Record Manual	X	X	X	

	Systems Record Manual	X	X	X	
	System Record Drawings	X	X	X	
	System Operation and Maintenance Manual	X		X	
	System Training DVDs	X		X	
	System Certification		X	X	
	Software, Source Code and Art Work	X		X	
	Guarantee Certificate			X	
	System Serv. & Tech. Assistance Schedule	X		X	

1.21 TABLE 28 0510-2 - TRAINING SCHEDULE

A. The Contractor in coordination with the system manufacturers shall provide Training Operation, Programming and Maintenance for each system specified in Division 28 as shown on the Training Schedule included in this Section. The system training and training manuals shall be specifically for the systems provided under this project.

Specification Sections	Description	Sessions	Time Each Hours	Comments/ Reference Section
281300	aCCESS CONTROL			
	□ Operation □ Software □ Maintenance	3 3 2	4 4 4	
287000	WATCH TOUR			
	□ Operation □ Programming □ Maintenance	2 1 1	4 4 4	
284000	TOUCH SCREEN / PLC SYSTEM			
	□ Operation □ Programming □ Maintenance	3 2 2	4 4 4	
285000	INTERCOM/PAGING SYSTEM			

	□ Operation □ Programming □ Maintenance	3 2 2	4 4 4	
282300	VIDEO SURVEILLANCE			
	□ Operation □ Programming □ Maintenance	3 2 2	4 4 4	

PART 2 PRODUCTS

(NOT USED).

PART 3 EXECUTION

(NOT USED).

END OF SECTION

SECTION 28 0520
CONTROL CONSOLES, CABINETS AND ENCLOSURES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

B. Refer to all Contract Drawings and specification sections listed in Section 28 0500 and 28 0510 for additional requirements.

C. Refer to Divisions 8, 26, and 27 for additional requirements and coordination efforts.

1.02 DESCRIPTION OF WORK

A. Provide cabinets, enclosures and equipment racks to house Division 28 equipment as described or identified in these Contract Specifications and Drawings.

B. Coordinate the installation location requirements with the Architect & Engineer and Owner as required.

C. Provide locking type protection enclosures for all electronic devices and modules installed in the control workstation cabinets. Provide keying as required by Owner. Provide louvers and thermostatically controlled venting for all console sections that house heat-sensitive electronics.

D. The Contractor shall be responsible for the interfacing and integration of all devices and systems with the work under separate Divisions, such as: Fire Alarm Systems and Electrical Infrastructure, Tele/Data Systems.

PART 2 PRODUCTS

2.01 CONTROL WORKSTATIONS

A. Security monitors and control equipment in Central Control, Housing Units, Medical, and Booking shall be mounted on countertops provided by other trades.

2.02 HOUSING UNIT AND LOCAL WORKSTATION CABINETS

A. Computer workstations in Central Control, Housing Units, Medical, and Booking shall be secured below the desk top surfaces in a secure cabinet.

B. Provide under-work surface racks for computers and miscellaneous electronics.

C. Cabinets shall have the following characteristics:
   1. Rotate height 24-1/2” by 20” deep to fit under new work surface.
   2. Have a self contained track mounting system with side, top and rear panels.
   3. Provide full depth rack shelves for each rack.
   4. Support up to 40 pounds of weight.
   5. Thermostatically controlled. The noise produced by ventilating equipment shall not exceed 45dBA or 3dB(A) above ambient noise levels, whichever is lower.
   6. Forced air ventilated.
   7. Steel construction with lockable doors – Middle Atlantic DO-5-14.

D. Contractor shall ensure proper fit of equipment in cabinet and ensure proper fit in allotted space under desk tops in the Dormitory.

E. Cabinets shall be Middle Atlantic Slim 5 Series, Part No. 5-14-26, or approved equal.

2.03 EQUIPMENT RACKS/PANELS

A. Provide quantity of equipment racks as shown on the Contract Drawings.

B. Equipment racks shall have the following features:

1. Mounting rails for standard 19” equipment.
2. Top, bottom and side panels painted black.
3. Wireways and wire management features to allow for proper workmanship, routing, bundling, securing and dressing of all cables.
4. Fans, louvers, filters and thermostat control for the clean efficient exhaust of heat from the enclosure.
5. Pull-out light source shelf with movable and extendable light sources (min. 2) to assist with detailed rack work and identification.
6. Draw-out tray to place papers, laptop or tools during rack access or work.
7. Power strips for equipment connection with 50% spare capacity.

C. Racks shall be placed in rooms to allow code-required access to front and rear doors.

D. Rack power strips shall be powered through rack-mounted UPS.

E. Racks shall be bolted to the floor.

F. Cables shall enter racks overhead from the cable tray system or wire management system. Cable tray curved, ladder-type, dropout connectors shall connect between the bottom of the cable tray and top of rack. All cables shall be secured to the connect rung.

G. Floor-mounted racks shall be as manufactured by Middle Atlantic WRK Series, or approved equal by Winsted or Hubbell.

H. Pull out floor mounted racks shall be as manufactured by Emcor ESQ, Middle Atlantic WR Series, or approved equal by Winsted or Hubbell.

2.04 EQUIPMENT ROOM AND CONSOLE WIRING

A. All control room and workstation wiring shall be concealed and run in metallic channel type raceways except for up to 6” runs from the wiring channel to the individual equipment termination points.

B. The system wiring shall allow for easy and efficient servicing.

C. Provide DIN rail mounted, UL listed connectors as manufactured by Woertz (PA), Phoenix, Allen Bradley, or equivalent. Provide surge protection at/with the terminal boards and connectors for each circuit connected to devices and systems outside of the Building. Electric power to distribution panels and boxes are specified in Division 26. The Contractor shall provide electric power to the console and security systems equipment. The Contractor shall coordinate all work provided under this contract with work provided by others as required to meet the intent specifically described herein.

D. The Contractor shall ensure that all signal transmissions, switching and processing meets the manufacturer's requirements for phase and synchronization.

E. Coordinate UPS/Power distribution panels, circuit breakers for Security Systems equipment with Electrical provider specified elsewhere in these specifications. The neutral conductor will be bonded to the building master ground system as required under NFPA 70, NEC, Article 250-74.

F. All electric power circuit conduit and boxes shall be metal.

G. The Contractor shall provide branch circuits, wired individually from the dedicated circuit breaker power/UPS panels using minimum three #12 AWG wires. Every powered device shall have a direct path to the unipoint ground busbar without noise being injected by other outlets.

H. The Contractor shall provide insulating materials, as required, to isolate equipment racks from all conduit, outlet boxes and raceway components.

I. The Contractor shall use isolation techniques, as required, to isolate equipment racks from ventilation ducts and building steel.

J. The Contractor shall provide in each rack, a copper busbar as an isolated ground unipoint - for connection of grounding conductors used for the equipment in that rack.

K. The Contractor shall provide connection of each rack's busbar to the ground busbar in the circuit breaker panel using #4 AWG insulated copper conductor.

L. The Contractor shall provide connection of each rack's ground busbar to the rack frame by means of a tightly attached lug and connection shall be made between lug and ground busbar using #12 AWG stranded wire, type TW.

M. The Contractor shall coordinate with the Division 26 work all electrical power, grounding and surge protection as required to meet the provisions of NFPA 70 - National Electric Code, Article 250-74 for isolated ground type installations.

N. For 600 volt and lower voltage power conductors, Burndy clamp type solderless connectors shall be used in making up taps, splices, and connections, and shall be padded with Scotchfil electrical insulation putty and taped with Scotch electrical tape no. 33, unless otherwise specified. As an alternative, connector may be insulated with a homogenized rubber based insulating compound backed by sheet vinyl equal to Scotch "E-Z Seal" #2200 (pads) or #2210 (tape). Such insulating compound shall be over-wrapped with (2) layers of PVC electrical tape.

O. Any splices shall be made up with butt spaces, crimped with approved tooling.

P. Provide code required fire stopping at all fire rated wall, floor and partition penetrations with UL listed fire stopping materials such as 3M Fire Barrier CP255/L and 25N/S caulk, or equal

2.05 EXTERIOR INTERCOM PEDESTAL

A. Provide single and dual height intercom pedestals to house card readers, intercoms, and cameras as listed within the Contract Documents.

B. Intercom pedestals shall meet the following requirements:
   1. Constructed of 14-guage cold rolled steel
   2. All welded construction
   3. Housing for Camera, Intercom Substation, and Card Reader
   4. Black polyester coating
   5. Dual Height shall have 48” and 72” high mounting brackets on 2” pipe.
   6. Single Height shall have 48” high mounting bracket on 2” pipe
   7. Mounted on 3/8”x12”x12” reinforced steel base.

C. Intercom pedestal shall be as manufactured by Chase or approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. Provide all materials and equipment as required to construct control panels and consoles to support the requirements of Contract Drawings and Specifications.

B. The SSC shall coordinate installation of all equipment which is to be installed in console whether included in this Section or existing.

C. The Contractor shall provide coordination with work of other Divisions as required. Contractor shall provide and install all equipment necessary for interfacing with all related systems.

3.02 ADJUSTING, TESTING AND CLEANING

A. General:
   1. Upon completion of the Work, remove excess debris, materials, equipment, apparatus and tools, and leave the premises clean, neat and orderly.

B. Testing:
   1. Contractor shall test system completely prior to acceptance tests.

2. Acceptance tests shall be conducted by the Owner or Owner's representative and Architect & Engineer to ensure compliance with plans and specifications.

3.03 SUBMITTALS

A. Refer to Sections 28 0500 and 28 0510.

END OF SECTION

SECTION 28 1300
SECURITY ACCESS CONTROL SYSTEM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

B. Refer to all Contract Drawings and specification sections listed in Section 28 0500 and 28 0510 for additional requirements.

C. Refer to Division 26 and 27 and the Electrical drawings for coordination requirements for power and infrastructure.

1.02 SYSTEM DESCRIPTION

A. Control Access to building and selected areas using proximity cards.
   1. Selected Exterior Doors: Control access into building at locations as shown on drawings.
   2. Selected Interior Doors: Control access into areas as shown on drawings.

B. Restrict Access of individual cardholders by time of day, day of week and specific points of entry via system software.

C. Monitor Points in building and selected areas as shown on drawings that provide unauthorized access or egress and may be a point for forced entry. The system shall report changes in status for all monitored points indicating the specific location so the operator can respond appropriately.
   1. Selected Exterior Perimeter and Internal Points: Provide four-state supervised inputs to system for monitoring the status of doors.
   2. Furnish Intrusion Detection Devices under provisions in this specification.

D. Provide Video Monitoring of doors and alarms when access is requested or a door is opened. This is provided by connection between the Access Control System, PLC Control System, and Video Surveillance System.

E. Access Control System Server Workstation shall be integrated into the Central Control Center Touchscreen Computer (TSC) System. It shall provide a real-time display of all system events, archive all events in a history file on the hard disk and serve as the instrument through which all system programming is accomplished. Workstation shall be configured for the intended system function by loading the appropriate services and operating system software.
   1. Access Control System Server Workstation: shall be installed in location determined by the Owner and shall run the system database service for interfacing with the TSC/PLC control system for polling and communicating with the card readers, a user interface for monitoring system activity and database administration. The system server workstation shall have the operating system for the access control software function installed. All pertinent access control shall be integrated into the Central Control Center's Touchscreen Computer System. Lock control shall be through the PLC and the associated interfacing relays.

F. Provide monitoring of selected doors as shown on the Contract Drawings. Coordinate with the door hardware provider.

G. Provide interfacing to Fire Alarm System for automatic release/unlocking of selected doors in the path of egress upon fire alarm in non-detention areas.

H. Provide all necessary programming for a fully functional Access Control System.

I. Provide interface to Video Surveillance System for Video – Follow – Alarm.

J. Provide 300 Access Control proximity cards.

K. Provide report generation for all alarm signals.

L. Provide card access proximity card printing including digital picture. Coordinate the location of the badging station with the Owner.

M. Provide all power supplies for access control equipment and door locks. All access control systems including card readers, computer systems and door lock power supplies shall have battery backup UPS power.

1.03 GENERALIZED DESCRIPTION OF WORK

A. Provide Access Control System including system software residing on control system computers, controllers, card readers, PLC interfaces, cards and badging station.

B. Interface to PLC system for electric lock control.

C. Interface to PLC system for monitoring magnetic door switches.

D. Provide all required power supplies. Coordinate with the Electrical Contractor.

E. Provide all cabling connections required.

F. Coordinate with the Electrical Contractor all conduit requirements.

G. Coordinate with door hardware and door supplier.

1.04 RELATED WORK

A. In addition to work described above under DESCRIPTION OF WORK, the work shall include, but not necessarily be limited to, the following:
   1. Rigging of equipment and materials including all miscellaneous steel and hangers for support of all installed equipment.
   2. Assembly of all equipment furnished disassembled.
   3. Testing and start-up of all equipment supplied.
   4. Cleaning of all apparatus specified elsewhere.
   5. Equipment identification as specified herein and elsewhere.

PART 2 PRODUCTS

2.01 OVERVIEW

A. The products specified herein were the latest generation at the time of specification and provide the functionality and intent of the system requirements. The Contractor shall provide, at the time of product submittal, the manufacturers latest generation of products, hardware and software, with equal or greater functionality.

B. The devices described herein are intended to provide a reference for the Card Access / Security System, and are to be provided as described in the Contract Documents.

C. All system components shall be approved for the function they will perform.

2.02 MANUFACTURERS

A. Proximity Cards and Card Readers shall be manufactured by HID Corporation, or approved equal.

B. Computers: As manufactured by Dell PowerEdge, Hewlett Packard, Lenovo, or approved equal.

C. Access Control Panels and Software: As manufactured by Software House or approved equal.

2.03 DATABASE

A. The system shall be of an open architecture design and shall support industry standard databases such as Microsoft SQL Server, Oracle Server, IBM DB2 or MSDE database.

B. The database shall reside on the system server at Central Control for district wide database services, system programming, system monitoring, administrative services, report, and proximity card generation.

C. The system shall be capable of utilizing a true client/server network configured to support the system database service, all services and user interfaces optimizing the users' options for system programming, event monitoring and record keeping.

2.04 SYSTEM SOFTWARE

A. Software Capacities:

1. System software and language development software shall be existing, industry-standard, and of a type widely used in institutional systems. Operating system shall be multi-user/ multi-tasking capable of operating on a non-proprietary CPU. The application software, substantially as offered, shall be written in a high level, industry standard programming language. The system shall be modular in nature, allowing the system capacities to be easily expanded without requiring major changes to the system operation and maintaining all defined system data as well as historical information.
2. All System functions shall be accessible via point and click mouse control. Systems requiring command string control or complex syntax are not acceptable. The system software shall include the following features and be configured for a minimum:
   a. (256) readers.
   b. (250,000) active cardholder records.
   c. (30/256) simultaneous client PC licenses.
   d. (256) programmable holidays.
   e. Number of assets = 40,000.
   f. Operator accounts with unlimited definable privilege levels.
   g. Audible alarm annunciation at operator workstation.
   h. Unlimited graphic maps to be displayed on the operator workstation monitor.
   i. Remote network diagnostics.
   j. Event scheduling.
   k. An unlimited number of user defined card holder data fields.
   l. An unlimited number of door groups.
   m. An unlimited number of areas.
   n. Cardholder access privilege activation date and time.
   o. Cardholder access privilege expiration date and time.
   p. Americans with Disabilities Act (ADA) compliance in door and access operation.
   q. Interface and integration with Video Surveillance System.
   r. Field panel communications through various means including hardwired Ethernet network.

B. Software Operation:

1. The system shall provide a top-down configuration methodology. Top-down programming shall allow the system operator to configure the system software and hardware configurations in a logical flowing method. The system should allow the operator to start at the highest configuration level of the system and then move down through the lower configuration levels without having to move back and forth between a variety of menus.
2. Where the operator may be presented with a choice of pre-defined objects, the system shall provide a pop-up pick list. The operator may choose an object in the listing by clicking on the item. If the object has not been pre-defined, the operator may define the new object from the pop-up pick list.
3. The system shall utilize dynamic icons. The dynamic icons shall change appearance, in both color and icon display based upon the status of the associated object. This appearance change shall occur in real time and shall not require the system operator to

perform a screen refresh or exit the current screen.

4. Dynamic icons shall be provided to represent:
   a. Intelligent field panels.
   b. Door lock control.
   c. Cameras and domes.
   d. Alarm input.
   e. Output control relay.
   f. System/alarm event.
   g. Manual operator actions.
5. For intelligent field panels hard wired to the host computer, the dynamic icons shall reflect the true state of the device represented by the icon. For example, if an operator issues a command to unlock a door, and the field panel which controls that door is not in communication with the host computer, the icon shall not change state or appearance.
6. Where certain data fields within data screens may contain the same information, the system shall provide the ability to define default settings for these data entry fields. The operator shall be able to change the default setting without impacting objects that have already been defined.
7. Database Connectivity: The Security Management Control System shall be constructed to be database independent and shall support at a minimum Microsoft SQL Server 2008 (Express, Standard, or Enterprise), for data protection, redundancy and manageability. The system shall allow the ability to perform writes to the system database to import personnel data directly into that database. This data shall then be automatically downloaded to field devices in the same way as manually entered information.
8. The software manuals for the Security Management Control System shall provide complete documentation outlining the database schema used within the system. This documentation should be sufficient to allow a person, moderately skilled in databases, to extract information from the Security Management Control System's databases. The database schema information shall include information on the personnel tables, history and configuration tables.
9. It shall be possible to use third party report tools, such as Crystal Reports, to generate reports not already provided by the Security Management Control Systems, such as statistical or graphical reports of system activity.
10. Database password protection: Database level Username and Password protection shall be provided for users. Users will be required to supply a Username and Password when they connect to the SMCS database. Usernames and passwords shall be configured via the user configuration functionality currently available in the Administration utility.
11. Date format: The system shall support the date being formatted in DD/MM/YY or MM/DD/YY, depending upon local date formatting.
12. Card reader LCD panels: The system administrator shall be able to define the language and date format that shall be used for display of messages on reader LCD panels

C. Web Client:
   1. The system shall support a Thin Client to provide remote access to the Access Control System Server Workstation via a web browser. The Thin Client shall support at a minimum Microsoft® Edge, Mozilla Firefox® , Google™ Chrome. The Thin Client shall support 128-bit encryption using SSL for secure communication between server and clients.
   2. The Thin Client shall support Single Sign-on utilizing Windows Authentication. The privileges of the Access Control System operator shall be propagated to the Thin Client User allowing only access to Security Objects for which the Access Control System Operator is authorized. The Thin Client shall provide support for Partitioning of the system and utilize the Partitions assigned to the Operator.

3. The Thin Client shall support an Activity Monitor to provide a scrolling display of system activity. Activity shall be restricted based upon the Operator's Privilege and Partition assignments. Display controls shall include page up, page down, and a freeze function.
4. The Thin Client shall support the ability to display a door activity report from the web client cardholder record configuration view. In addition, it shall provide the ability to display the Activation / Expiration Date and Time for each credential assigned to a cardholder. The thin client shall display all user-defined personnel fields and the details of each assigned access clearance in a separate window.

2.05 CARD READER

A. Provide for all doors as outlined on the Contract Drawings, high-security vandal-proof cardreaders.

B. The multi-technology contactless smart card reader(s) shall be designed to securely read, interpret, and authenticate access control data from 13.56 MHz contactless smart card credentials and 125 kHz proximity cards.

C. Global, off-the-shelf availability.

D. Multi-technology contactless smart card reader shall provide the following programmable audio/visual indication:
   1. An audio beeper shall provide various tone sequences to signify: access granted, access denied, power up, and diagnostics.
   2. A high-intensity red/green/blue light bar shall provide clear visual status. The light bar shall provide uniform distribution of light eliminating individual bright spots.

E. Multi-technology contactless smart card reader shall provide the ability for mounting to standard electrical boxes through the use of universal international mounting holes.

F. Multi-technology contactless smart card reader shall meet all applicable radio and safety regulatory compliance including but not limited to:
   1. UL294
   2. FCC Certification

G. Multi-technology contactless smart card reader shall be designed for low current operation to enable contactless smart card migration from most legacy proximity applications without the need to replace existing access control panels and/or power supplies. Contactless smart card power requirements shall be:
   1. Operating voltage: 5 – 16 VDC, reverse voltage protected. Linear power supply recommended.
   2. Current requirements and power consumption:
      a. Standard power mode: 75 mA
      b. Peak current draw: 110 mA
      c. Standard Power Mode @ 16VDC: 1.2 W

H. Multi-technology contactless smart card reader shall meet the following physical specifications:
   1. Dimensions allowing mounting on a standard single gang box.
   2. Color: black or charcoal gray as approved by the Owner and Architect.

I. Multi-technology contactless smart card reader shall meet the following environmental specifications:
   1. Operating temperature: -31 to 150 degrees F (-35 to 65 degrees C)
   2. Operating humidity: 5% to 95% relative humidity non-condensing
   3. Weatherized design suitable to withstand harsh environments with a certified rating of IP55

J. Card reader shall be flush-mounted.

K. The card reader shall be fully compatible with the ACS.

L. Multi-technology contactless smart card reader shall be as manufactured by HID multiclass SE Model RP40, or approved equal. Where narrow readers are required, HID multiclass SE Model RP10.

2.06 ACCESS CARD REQUIREMENTS

A. Access cards shall be HID iCLASS 13.56MHz contactless smart card technology and compatible with card readers and ACS software.

B. The Vendor shall be responsible for providing a cross-reference list showing the serial number and the embedded number for each card.

C. Each card shall have a return address if found.

D. Each card shall have, preprinted by the factory, one side of the card. The preprinted information could contain County logo, return address, or any color graphic as directed by the Owner. The manufacturer shall display different designs to assist the Owner with choice.

E. Cards shall be pre-fabricated, credit-card size card constructed of molded plastic. A punched slot shall be provided for a strap or clip. The card shall be capable of having multi-color custom graphics and permanently marked numbers printed directly onto both sides. The card shall be made of robust ABS plastic to provide maximum protection for the circuitry inside and provide minimal flexing which could cause damage to the card. The user may specify codes or numbers and exact replacement of cards that may be have been lost, damaged or stolen shall be available upon request. All cards shall be passive devices with no internal battery, but shall contain a semiconductor element that is energized when brought within the operating range of the reader causing transmission of the code from the card to the reader.

F. Contractor shall provide three hundred (300) blank cards.

2.07 ACCESS CONTROL BADGING WORKSTATION

A. Provide badging workstation with Access Control computer workstation, camera, photo backdrop, and badging printer.

B. Badging camera shall have USB connectivity, minimum 5 megapixel resolution, and have table top mount with flexible arm. Manufactured by Videology Imaging Solutions, or approved equal.

C. Badge printer shall be compatible with provided access cards, HID Fargo series or approved equal.

2.08 ALLOWABLE CARD ACCESS TIME LIMITS

A. Under all conditions, maximum access time shall be 0.75 seconds.

B. Maximum allowable access time is defined as the time period starting with presentation of card to reader (completed read cycle) and ending with complete actuation of door release module (or relay as applicable). It does not include the mechanical time inherent to the unlocking mechanism.

2.09 ACCESS CONTROL SYSTEM SERVER WORKSTATION

A. The following are the server grade Access Control System Server Workstation requirements:
   1. CPU: Intel current generation Xeon quad core processor.
   2. Graphics: Radeon or nVidia 1GB (minimum).
   3. 10/100/1000 Mbps Ethernet interface card.
   4. System Software: Microsoft Server 2012 or latest generation operating system
   5. Program Software: Client component. Access Control System software as recommended by the Access Control System manufacturer.
   6. Memory: 16GB (minimum).
   7. Hard Drive: 1 TB (minimum).

2.10 COMMUNICATIONS

A. Refer to Sections 271000 Structured Cabling and 284000 Control System sections of the specification for requirements.

2.11 DOOR POSITION SWITCHES

A. The door hardware supplier shall provide concealed, biased, door position sensors for all doors that require monitoring as shown on the Contract Drawings.

B. Recessed magnetic door contacts shall be installed by the door and hatch hardware supplier on all doors as defined in the contract drawings.

C. Each magnetic door contact shall be configured by the Contractor as a separated alarm point. Double doors and banks up to six single contiguous or three contiguous double doors shall be configured as a single alarm point.

D. All magnetic door switches shall be wired, connected, and tested by the Contractor.

E. Coordinate with the door hardware suppliers.

F. If in a unique or difficult situation and a recessed magnetic door contact is not feasible, then a surface mount contact may be substituted if it meets the requirements of a high security biased switch configuration with concealed terminals, aluminum housing and armored cable.

G. Any doors found not already prepped to receive the recessed door contact shall be so fitted on site as part of this contract.

2.12 REQUEST-TO-EXIT (REX) PIR

A. Rex devices shall be UL listed and approved for egress application with the following features:
   1. Single or double door use.
   2. Wall or ceiling mountable.
   3. Internal vertical pointable with wrap-around coverage pattern.
   4. Adjustable latch time.
   5. Selectable fail-safe/fail secure mode.

B. Shall be Detection Systems, Bosch DS160, or approved equal.

2.13 DOOR RELEASE REQUEST TO EXIT PUSHBUTTON

A. Provide stainless steel door release pushbutton as manufactured by Doortronics WR5276, SDC, Securitron, or approved equal.

B. Door Release Pushbutton shall be engraved “PUSH TO EXIT”.

2.14 SECURITY DOOR HARDWARE

A. As outlined in the Door Hardware Schedule in the Architectural Specifications, the door hardware supplier shall provide electric strikes and electrified panic devices to be installed and connected by the security Contractor. Provide all door power supplies required.

PART 3 EXECUTION

3.01 INSPECTION AND PREPARATION WORK

A. This Contractor must examine the conditions under which the system installation is to be performed and notify the Owner’s Representative or Design Professional in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to provide a workmanlike installation.

B. Review all areas of potential interference and resolve conflicts before proceeding with the work. Coordinate ceiling layout and wall layout and other work that penetrates or is supported throughout the space of the building. All work shall be flush and workmanlike in all finished areas.

3.02 INSTALLATION

A. Install materials and equipment in accordance with manufacturer's printed instructions to comply with governing regulations and industry standards applicable to the work and as shown on approved Shop Drawings.

B. Arrange and mount all equipment and materials in a manner acceptable to the Design Professional and Owner.

C. Coordinate with the Owner all programming for access control privileges, control restriction, normal operations, off hours and holiday schedules, report generation, badging configuration and information and pin number generation before Final Acceptance. Make minor adjustments at no cost to the Owner during the warranty period's two routine inspection periods as outlined in Section 28 0500.

D. Installation shall conform to the basic guidelines:
   1. Use of approved wire, cable, raceways, wiring, devices, hangers, supports and fastening devices.
   2. Separation of high and low voltage wiring is required throughout the installation.
   3. All wiring shall be thoroughly tested for grounds and opens before final connection.

E. Conduit shall be provided for risers. Horizontal wiring shall run without conduit unless required by code, see - QUALITY ASSURANCE. All power wiring shall be in metallic conduit. The maximum conduit fill shall not exceed 40% of rated capacity. Refer to NFPA 70-NEC for additional requirements.

F. Cabling and Wire Requirements:
   1. Refer to Section 28 0500 for all raceway, surge and wiring requirements.
   2. The individual systems low voltage cabling shall use separate conduit/raceway junction boxes and enclosures, then electric power cabling.
   3. The minimum low voltage input/output cabling for Access Control System shall be #18 AWG unless specifically specified on the Contract Drawings. Provide minimum 3 pair, twisted, individually shielded pair type cabling for card readers and keypads. All cabling shall be jacketed. The systems cabling shall meet the requirements of NFPA 70/NEC Articles 725, 760 and 800 as applicable for each type of system specified.
   4. The minimum bend radius of all conduits provided by others is 6 inches. Provide and maintain pull strings/tapes/ropes in all conduits for future installation of additional cabling.
   5. All pull strings installed or placed in conduits that already contain, or that will contain system cabling, shall be able to be removed from the conduit without causing any damage to the cabling already contained with same conduit(s).

G. Junction Boxes, Enclosures/Cabinets, Equipment Racks:
   1. The equipment enclosures shall be installed at approved locations and be typically ventilated as required to maintain the environmental conditions specified by the electronic equipment manufacturers.
   2. All junction boxes and pull boxes shall be labeled. The box label shall state the system and use of cabling. The labeling shall be made with markers which are indelible when and after in contact with water and oil.
   3. Each box and enclosure shall contain a cabling and wiring log identifying all cabling accessible whether it is connected or is passing by.
   4. Refer to other sections of this Specification for additional requirements.

H. Grounding and Surge Protection:
   1. Provide single point grounding of the individual systems as recommended by IEEE and system manufacturers. Provide all cabling, bonding and insulation materials as required. Provide surge protection and clamping for all circuits. Coordinate all grounding, surge protection and manufacturers.

2. Coordinate grounding requirements with other trades and contractors to preclude closing of ground loops via peripheral equipment supplied from different electrical power sources. Provide isolation transformers and other equipment as required.

3.03 SPECIAL TOOLS, EQUIPMENT AND MATERIALS

A. The Contractor shall deliver to the Owner's Representative all special tools, equipment and materials necessary to maintain the system provided under this Contract.

3.04 ADJUSTING, TESTING AND CLEANING

A. Contractor shall be required to perform complete testing and verification of the following:
   1. Card reader maximum access time shall be 0.75 seconds under all system loads.

B. Refer to Section 28 0510 for additional requirements.

3.05 AS-BUILTS

A. Refer to Section 28 0510.

3.06 SUBMITTALS

A. Refer to Sections 28 0500 and 28 0510.

3.07 TRAINING

A. Refer to Section 28 0510.

END OF SECTION

SECTION 28 2300
VIDEO SURVEILLANCE CAMERAS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. Section 28 23 13 – Video Surveillance Control and Management System

1.02 SUMMARY

A. Installation of equipment must meet the Pennsylvania Department of Corrections construction standards.

B. These specifications outline the acceptable characteristics for materials and equipment and define, in general terms, the configuration of the security system camera technologies to be installed and made fully operational by the selected Security System Contractor (Contractor) of the Video Management System (VMS).

C. Contractor shall have total “turn-key” responsibility (except where noted) for ensuring the system is installed complete and functional, consistent with the manufacturer's specifications and that all applicable fire, electrical, and building codes and standards are met. Where required by the various codes, the vendor is responsible to obtain the necessary approval(s) of the Authority Having Jurisdiction (AHJ).

D. Section includes a video surveillance system cameras and mounts. VMS platform and network infrastructure provided in separate specifications.

E. Any aspect of these specifications, or future addendum, which appears to the Contractor to fall outside applicable codes or standards, shall immediately be brought to the attention of the Architect.

1.03 GENERAL REQUIREMENTS

A. The specified camera product shall be an open video platform designed for use in any video application.

B. Contractors shall provide all necessary channel licensing for the proposed VMS.

C. System cameras shall be minimally ONVIF profile S and/or T compliant, have a 5-year manufacturer guarantee, utilize both H.265 and H.264 compression and be appropriately IP (ingress protection) and IK (vandal resistance) rated for the environment.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum 5-year experience manufacturing similar products.

B. System Integrator shall provide the following as part of the System Solution:
   1. Complete product and technical data specification sheets that include all material and equipment and shall be available freely online.
   2. A bill of material of all equipment with part numbers, manufacturer, firmware, and assigned IP addresses.
   3. Locations and details for all components to be installed under this scope of work.
   4. Placement Diagram showing the proposed location of all system hardware devices.

C. Installer Qualifications: Minimum 2-year experience installing similar products. Installers shall be trained and authorized by the Manufacturer to install, integrate, test, and commission the system.
   1. Installer working on this project must possess a valid certificate from the equipment manufacturer verifying completion of Installation and Service Training.

D. Installing contractor shall provide at least 3 examples of projects of similar size and scope to include:
   1. Project name
   2. Project locations
   3. Project description
   4. Contact name, email address and phone number

E. Complete product and technical data specification sheets that include all material and equipment shall be provided by the System Integrator and be available freely online.

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

G. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

1.05 PROPOSAL SUBMITTALS

A. Follow all requirements noted on the Form of Proposal

B. Submit Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Manufacturer’s printed or electronic data sheets.
   2. Manufacturer’s installation and operations manuals.
   3. Manufacturer’s warranty information.

C. Include individual device counts by model number, mounts, and other required appurtenances required for a fully functional video management system.
   1. Provide installation diagrams and pertinent information for all devices, i.e. rack space for recorders, power requirements, rough-ins, etc.
   2. Provide a spreadsheet detailing each camera, model, IP and MAC address, firmware, included mounts and other hardware as needed.

1.06 ONGOING SUPPORT AND WARRANTY

A. Manufacturer shall provide a limited 5-year warranty for each camera to be free of defects in material and workmanship

1.07 DEFINITIONS

A. AGC: Auto Gain Control

B. AI: Artificial Intelligence

C. AES: Advanced Encryption Standard

D. API: Application Programming Interface

E. ARP: Address Resolution Protocol

F. AWB: Auto White Balance

G. BLC: Back light compensation

H. CBR: Constant Bit Rate

I. CVBS: Composite Video Blanking and Sync

J. DHCP: Dynamic Host Configuration Protocol

K. DNR: Digital Noise Reduction

L. DNS: Domain Name Server

M. DDNS: Dynamic Domain Name Server

N. DSCP: Differentiated Services Code Point

O. FOV: Field of View (of the camera)

P. Fps: frames per second
Q. FTP: File Transfer Protocol
R. GOV: Group of Video
S. GUI: Graphical User Interface
T. HD: High Definition
U. HTTP: Hypertext Transfer Protocol
V. HTTPS: Secure HTTP
W. ICMP: Internet Control Message Protocol
X. IGMP: Internet Group Management Protocol
Y. IP: Internet Protocol
Z. IR: Infrared
AA. JPEG: Joint Photographic Experts Group
BB. LAN: Local Area Network
CC. LED: Light Emitting Diode
DD. LDC: Lens Distortion Correction
EE. LLDP: Link Layer Discovery Protocol
FF. LPR: License Plate Recognition
GG. MJPEG: Motion JPEG
HH. MP: Megapixel
II. MPEG: Moving Pictures Experts Group
JJ. NAS: Network Attached Storage
KK. NTP: Network Time Protocol
LL. NVR: Network Video Recorder
MM. Protocol Independent Multicast-Sparse Mode
NN. PoE: Power over Ethernet
OO. PPPoE: Point to Point Protocol over Ethernet
PP. QoS: Quality of Service
QQ. RTP: Real-Time Transport Protocol
RR. RTCP: Real-Time Control Protocol
SS. RTSP: Real-Time Streaming Protocol
TT. SDK: Software Development Kit
UU. SFP: Small Form Factor Pluggable
VV. SMTP: Simple Mail Transfer Protocol
WW. SNMP: Simple Network Management Protocol
XX. SSDR: Super Smart Dynamic Range
YY. SSNR: Super Smart Noise Reduction
ZZ. SSL: Secure Sockets Layer
AAA. TCP: Transmission Control Protocol

BBB. UDP: User Datagram Protocol

CCC. UPnP: Universal Plug and Play

DDD. VBR: Variable Bit Rate

EEE. VMS: Video Management System

FFF. WDR: Wide Dynamic Range

1.08 REFERENCE STANDARDS

A. Abbreviations
   1. Network - IEEE
      a. Ethernet Standards
      b. x Port-based Network Access Control
      c. IPv4 IP addressing version 4
      d. IPv6 IP addressing version 6
      e. QoS Quality of Service
   2. Video
      a. ISO / IEC 23008-2:2013, MPEG-H Part2 (ITU H.265, HEVC)
      b. ISO / IEC 14496–10, MPEG-4 Part 10 (ITU H.264)
      c. ISO / IEC 10918 – JPEG
      d. ONVIF – Profiles S, G, T
   3. EMC & Safety
      a. FCC 47 CFR Part 15 Subpart B
      b. ANSI C63.4-2014 Class A
      c. IC Regulation ICES-003:2016
      d. ANSI C63.4-2014 Class A
      e. CE EMC-Directive 2014/30/EU
      f. EN 55032:2015 Class A
      g. EN 50130-4:2011+A1:2014
      h. VCCI-CISPR 32: Class A
      i. AS/NZS CISPR32:2015 Class A
      j. UL listed
      k. CE EN 50581:2012 (hazardous substances)
   4. Safety
      a. UL listed
      b. CE EN 50581:2012 (hazardous substances)
   5. Ingress Protection and Vandal Resistance
      a. ANSI / IEC60529 – Degrees of Protection Provided by Enclosures – IP52
      b. IEC EN 62262 - Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts: IK10
      c. IEC 60068-2-75: IK10

B. Definitions
   1. GOV (Group of Video object planes) - A set of video frames for H.264 and H.265 compression, indicating a collection of frames from the initial I-Frame (key frame) to the next I-Frame. GOV consists of 2 kinds of frames: I-Frame and P-Frame.
   2. Dynamic GOV – Dynamic assignment of GOV length based on the complexity of the scene to efficiently manage bitrate of the video stream and reduce the storage required.
   3. Multi-exposure wide dynamic range - Operation which automatically adjusts shutter speed to provide a wide range between dark and light areas visible at the same time, preventing backlighting issues. Long exposure is used for dark areas and a short exposure is used in light areas.

4. Dynamic fps – Dynamic assignment of fps (frames per seconds) based on the movement of object(s) in the scene to efficiently manage bitrate of the video stream and reduce the storage required.
5. Smart Codec – Smart Codec that controls quantization parameter and dynamic fps in H.265 and H.264 to efficiently manage bitrate of the video stream and reduce the storage required.
6. WiseStream Ⅱ – Technology that controls quantization parameter, fps, and GOV length in H.265 and H.264 to efficiently manage bitrate of the video stream and reduce the storage required.

1.09 SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.

C. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
2. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
3. Wiring Diagrams: For power, signal, and control wiring.
4. Floor and site plans showing camera locations with camera identification numbers.
5. System storage calculations to meet the requirements outlined within these specifications.

D. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

1.10 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, network recorders (server/storage), to include in emergency, operation, and maintenance manuals.

B. Lists of spare parts and replacement components recommended to be stored at the site for ready access (if applicable).

C. Complete hardcopy printout and electronic copy from the system Device Manager which outlined system and camera configuration, which includes camera model number, IP address, and MAC address, camera image FOV (camera image snapshot) at the time of installation and other system settings.

D. As-built drawings on facility floor plans showing camera installed location, wiring and cable routes, termination points, and other system drawing needs to meet the owner’s requirements.

1.11 DISCLOSURE OF NON-CONFORMING EQUIPMENT

A. Project owner desires to make an informed decision regarding the Contractor's proposed project approach, mobilization, staging and overall implementation schedule of tasks.

B. Contractor is required to disclose, separate from any cut or advertising sheets, any functional, operational or electrical requirements of these specifications that they are not able to perform, and/or which fall outside the scope of their quotation.

C. The form of this disclosure shall be by letter clearly identifying these noncompliant items and describing how the Contractor intends to address these issues.

D. Absent such disclosure, Contractors shall be responsible for ensuring that their systems will fully operate as outlined in these specifications without additional cost to the owner or other parties.

E. Contractor may elect to provide an alternate design approach if cost savings could be realized. This approach shall be clearly outlined within their submittal and should not consider any sacrifice of system functionality or capacity.

PART 2 PRODUCTS

2.01 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 cameras are covered by 5-year manufacturers' warranty.

D. Basis of design for camera products are from Hanwha Techwin America.

E. Requests for substitutions will be considered; however, the contractor shall submit supporting documentation clearly describing functionality and features to meet or exceed the products named. Substitutions shall be submitted as per Contract Documents.

F. All multi-sensor camera devices shall have only one CATX network drop and one camera license on the VMS platform.

G. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.

2.02 DEVICE MANAGER

A. Provide and install the Hanwha Device Manager to manage Hanwha Techwin video surveillance devices in network including IP cameras, encoders, decoders, NVRs and DVRs by enabling users to remotely configure multiple devices simultaneously.

B. The software shall support backing up and restoring configuration data from multiple cameras. Backup file name shall include model number, IP address, and MAC address, and shall be user editable. Backup and restore shall be performed in parallel or sequential mode, and at a user desired relative or absolute time. The software shall support restoring a single configuration to multiple devices.

C. The software shall support setting camera image menu adjustments including SSDR, white balance, backlight compensation, exposure, day/night, special, & OSD. Image adjustments shall be performed and displayed on a selected camera immediately, and to other selected cameras per model upon selection.

2.03 CAMERA INTELLIGENCE AND ANALYTICS

A. Cameras shall have a suite of integral intelligent operations and analytic functions at no additional cost to the end-user on X, T and P-series models as outlined in products noted.

2.04 CAMERA SOFTWARE

A. The camera shall have a built in web server which supports browser-based configuration using Internet Explorer, Google Chrome, Mozilla Firefox, and Apple Safari from a PC or Mac.

B. The web viewer shall provide a monitoring screen which displays live camera video and simultaneously provides same-screen access to the following functions:
   1. Live view window size
   2. Resolution setting
   3. Image (snapshot) capture

4. Manual recording to SD or NAS
5. Audio/microphone control
6. Access recorded data playback and camera configuration menus
7. Digital PTZ

C. The web viewer shall provide a playback screen which provides access to the following functions:
1. Recorded data search using date and time range
2. Recorded data search using event type
3. Play a recorded video by event triggering
4. Set resolution
5. Play audio if present
6. Generate a backup copy of saved video data

D. The web viewer shall provide a setup screen which provides access to the following configuration settings and functions in the camera:
1. Digital video profile to include compression type, maximum or target bit rate, frame rate, multicast parameters, crop encoding area
2. User profile to include password, access level, authentication
3. Date and time
4. Network settings and IP version
    a. DDNS
    b. SSL/TLS, including certificate management
    c. x authentication
    d. Quality of Service settings
    e. SNMP to include version selection and settings
    f. Auto configuration
5. Video setup
    a. Flip / mirror mode
    b. Video output type
    c. Privacy zone
6. Audio setup to include source, audio codec type, gain, and bit rate
7. Camera settings to include image preset, sensor frame capture, dynamic range, white balance, back light, exposure, day/night operation, on-screen display, IR illumination, sharpness, contrast, color level, lens distortion correction.
8. Event detection setup to include notification parameters, recording rules, time schedule, tamper protection, motion detection, event triggers
9. System function to include reboot, upgrade, check system and event logs, application (SDK) management
10. View profile information

E. Client requirements
1. Recommend Browser: Chrome
2. Acceptable Browser: Chrome, Safari, Firefox, MS Edge (chromium based)
3. Windows, MAC, Android, iOS, Chrome
4. Verified Environment:
    a. Windows 10 : Google chrome version 80 above, Firefox version 72 above, MS Edge version 83 above
    b. Mac 10.13/14: Safari version 11.0.1 above

F. Decoding performance in web viewer depends on CPU/GPU performance of user

2.05 CAMERA TYPES

A. Camera Type 1

1. Video Surveillance Camera - 5MP Vandal-Resistant IR Network Dome Camera

B. Camera Type 2
   1. Video Surveillance Camera - 15MP Panoramic Multi-Sensor Camera

C. Camera Type 3
   1. Video Surveillance Camera - 12MP 360˚ Fisheye Camera

D. Camera Type 4
   1. Video Surveillance Camera - 3MP IR Vandal Corner Mounted Camera

E. Camera Type 5
   1. Video Surveillance Camera - 20MP (5MP x 4) Multi-Sensor, Multi-Directional PTRZ Camera

F. Camera Type 6
   1. Video Surveillance Camera - Dual Sensor (2MP x 2) Camera.

G. Camera Type 7
   1. Video Surveillance Camera – 2MP Small Form Factor Wide Angle Camera

2.06 CAMERA TYPE 1 – 5MP VANDAL-RESISTANT IR NETWORK DOME CAMERA

A. Must meet or exceed the operating characteristics of the Hanwha Techwin America 5MP XND-8080RV.
   1. Provide SBP-167HMW hanging mount pendant cap and SBP-300WM1wall mount for each device provided.
   2. Provide two (2) 256GB Micro SD/SDHC/SDXC cards for each camera to permit temporary edge storage if network connectivity is lost.

B. GENERAL DESCRIPTION
   1. Video Compression and Transmission – The camera shall have the following properties relating to the video signals it produces.
      a. H.265, H.264 and MJPEG compression, each derived from a dedicated encoder and capable of being streamed independently and simultaneously
         1) H.265 and H.264 – frame rates to maximum 30 fps at all resolution
         2) MJPEG – frame rates to maximum 30 fps
      b. The camera shall be able to configure up to 10 independent video stream profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
      c. The camera shall be able to configure various resolution selections
         1) 16:9 aspect ratio: 2560 x 1440, 1920 x 1080, 1280 x 720, 800 x 448, 640 x 360
         2) 4:3 aspect ratio: 2560 x 1920, 1600 x 1200, 1280 x 960, 1024 x 768, 800 x 600, 640 x 480, 320 x 240,
         3) 5:4 aspect ratio: 1280 x 1024, 720 x 576,
         4) 3:2 aspect ratio: 720 x 480,
      d. The camera shall be able to stream at least 10 independent video stream type using unicast protocol
      e. The camera shall support multicast and unicast video streaming
      f. The camera shall be able to configure Dynamic DNS (DDNS).
      g. Smart Codec, Dynamic GOV, and Dynamic fps to efficiently manage bitrate of the video stream.
   2. Camera – The camera device shall have the following physical and performance properties:
      a. Dustproof, waterproof, and IP67 rated.
      b. IK10 rated for protection against impacts.
      c. True day/night operation with removable IR cut filter

d. Low light level operation to 0.07 lux at F1.3 in color mode and 0 lux in black and white mode with IR LED on.
e. The camera shall support digital noise reduction using both 2D and 3D noise reduction technology
f. Integral IR illumination, providing effective visibility of 50m(164.04ft) at 0 Lux when activated in Black & White mode.
g. Configurable a privacy masking regions utilizing a 4-point polygon
h. The camera shall provide video display on smart phone (iPhone, Android) to adjust viewing angle, rotation and focus using a direct USB connection and/or Wi-Fi dongle.

3. Intelligence and Analytics – The camera shall have a suite of integral intelligent operations and analytic functions to include:
   a. Motion detection with eight definable detection areas with 8 point polygonal zones, minimum / maximum object size.
   b. Detection of logical events of specified conditions from the camera's video input
4. camera tamper (scene change)
   a. defocus detection
   b. fog detection
   c. motion detection with metadata
   d. face detection
   e. virtual area based event (intrusion, enter/exit, appear/disappear, loitering)
   f. virtual line based event (directional detection, crossing)
5. Detection of logical events of specified conditions from the camera's audio input
   a. Scream
   b. Gunshot
   c. Explosion
   d. Crashing glass
6. Interoperability – The camera shall be ONVIF Profile S and G compliant.
7. The camera shall possess the following further characteristics:
   a. Built-in web server, accessed via standard browsers including Internet Explorer, Firefox, Chrome & Safari
   b. Dual edge recording slot like Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals
   c. NAS recording option with configurable pre-alarm and post-alarm recording intervals
8. bi-directional audio
9. Alarms and notifications
   a. alarm notification triggers:
      1) motion detection
      2) tampering detection
      3) alarm input
      4) defocus detection
      5) fog detection
      6) face detection
      7) audio detection
      8) video & audio analytics
      9) network disconnection
   b. available notification means upon trigger:
      1) file upload via FTP and e-mail
      2) notification via e-mail
      3) record to local storage (SD card) or NAS storage
      4) external output
      5) move to DPTZ preset

10. Pixel Counter available in the web viewer.
11. PoE capable including heater by PoE

2.07 CAMERA TYPE 2 – 15MP PANORAMIC MULTI-SENSOR CAMERA

A. Must meet or exceed the operating characteristics of the Hanwha Techwin America 15MP PNM-9030V.
   1. Provide SBP-276HM hanging mount pendant cap and SBP-300WM1 wall mount arm for each device provided.
   2. Provide two (2) 256GB Micro SD/SDHC/SDXC cards for each camera to permit temporary edge storage if network connectivity is lost

B. GENERAL DESCRIPTION
   1. Video Compression and Transmission – The camera shall have the following properties relating to the video signals it produces.
      a. H.265, H.264 and MJPEG compression, each derived from a dedicated encoder and capable of being streamed independently and simultaneously.
         1) H.265 and H.264 – maximum of 30fps at all resolution
         2) MJPEG – maximum of 15fps at under 2MP
      b. The camera shall be able to select the panoramic mode between 180˚ and 220˚.
      c. The camera shall support panoramic stitching, original and crop view channels at the same time.
      d. The camera shall be able to configure up to 5(@180˚) or 3(@220˚) independent video stream profiles per channel with differing encoding, quality, frame rate, resolution, and bit rate settings.
      e. The camera shall be able to configure various resolution selections.
         1) 180˚ mode: 6096x2540, 5760x2400, 5472x2280, 5184x2160, 4800x2000, 4560x1900, 4096x1704, 3840x1600, 2688x1120, 2560x1064, 2048x852, 1920x800, 1280x532, 640x264
         2) 220˚ mode: 7744x1936, 6096x1524, 5760x1440, 5472x1368, 5184x1296, 4800x1200, 4560x1140, 4096x1024, 3840x960, 2688x672x 2560x640, 2048x512, 1920x480, 1280x320, 640x160
      f. The camera shall support unicast video streaming up to 15 users.
      g. The camera shall be able to configure Dynamic DNS (DDNS). DDNS shall be provided with no additional cost by the manufacturer.
      h. The camera shall provide smart codec (WiseStream Ⅱ, Dynamic GOV, and Dynamic fps) to efficiently manage bit rate of the video stream and reduce storage while producing video quality that is visually equal to the one without smart codec.
   2. Camera – The camera device shall have the following physical and performance properties:
      a. The camera shall be able to produce clear images in highly contrast scenes with multi-exposure wide dynamic range up to 120dB.
      b. The camera shall support digital noise reduction using both 2D and 3D noise reduction technology.
      c. The camera shall be able to configure 16 privacy masking areas with rectangles.
      d. The camera shall have the defog feature to remove fogginess of scene which can be triggered automatically from the fog detection event.
   3. Intelligence and Analytics – The camera shall have a suite of intelligent analytic functions.
      a. Motion detection with eight definable detection areas with eight point polygonal zones, and minimum/maximum object size.
      b. Motion detection handover to call a preset of PTZ camera when motion event is triggered.
      c. Detection of logical events of specified conditions from the camera's video

1) Tampering
2) Loitering
3) Directional detection
4) Virtual line
5) Enter/Exit
6) (Dis)Appear,
7) Audio detection
8) Motion detection
9) Sound Classification
10) Heatmap

d. Detection and classification of the following sound.
1) Scream
2) Gunshot
3) Explosion
4) Crashing glass

4. Interoperability – The camera shall be ONVIF Profile S and G compliant.
5. The camera shall possess the following further characteristics:
a. Built-in web server, accessed via non-plugin browsers including Google Chrome, MS Edge, Mozilla Firefox and Apple Safari.
b. Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals
c. NAS recording option with configurable pre-alarm and post-alarm recording intervals
d. Alarms and notifications
1) alarm notification triggers:
(a) Alarm input
(b) Motion detection
(c) Video & Audio analytics
(d) Network disconnect
2) available notification means upon trigger:
(a) File Upload via FTP and E-mail
(b) Notification via E-mail
(c) Local storage (SD / SDHC / SDXC) or NAS recording at event triggers
(d) External output
e. Pixel Counter available in the web viewer.
f. PoE+ capable
g. IP66, IK10 capable

2.08 CAMERA TYPE 3 – 12MP 360˚ FISHEYE CAMERA

A. Must meet or exceed the operating characteristics of the Hanwha Techwin America PNF-9010RV.
1. Provide SBP300HMW5 hanging mount pendant cap and SBP-300CM pendant mount for each device provided.
2. Provide one (1) 128GB Micro SD/SDHC/SDXC card for each camera to permit temporary edge storage if network connectivity is lost.

B. GENERAL DESCRIPTION
1. The 4K fisheye camera shall have ultra-wide angle lens that produces videos in wide angels of view and shall provide on-board dewarping to convert hemispherical images into rectangular images which are more suitable for human eyes.
2. Video Compression and Transmission – The 4K fisheye camera shall have the following properties relating to the video signals it produces.

a. H.265, H.264 and MJPEG compression, each derived from a dedicated encoder and capable of being streamed independently and simultaneously
    1) H.265 and H.264 – frame rates to 25 fps
    2) MJPEG – frame rates to 15 fps
b. The 4K fisheye camera shall be able to configure up to 10 independent video stream profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
c. Resolution selections
    1) Fisheye: 4000x3000, 2992x2992, 2560x2560, 2048x2048, 1280x1280, 640x640
    2) Double panorama: 2560x1280, 1920x960, 1280x640, 704x352, 640x320
    3) Single panorama: 2560x640, 1920x480, 1280x320, 704x176, 640x160
    4) Quad view: 2944x2208, 2560x1920, 2048x1536, 1600x1200, 1280x960, 1024x768, 800x600, 704x576, 640x480
d. Simultaneous unicast access by up to 15 users
e. Multicast or unicast capable
f. Dynamic DNS (DDNS) support.
g. The 4K fisheye camera shall provide smart codec (WiseStream, Dynamic GOV, and Dynamic fps) to efficiently manage bit rate of the video stream and reduce storage while producing video quality that is visually equal to the one without smart codec.
h. On-board dewarping

3. Viewing composition
    a. Camera side: Fisheye, Single panorama, Double panorama, Fisheye + 4 PTZ, Quad view, Fisheye + 8 PTZ
    b. 16x Digital Zoom
    c. Digital PTZ with preset and group
4. Camera – The 4K fisheye camera device shall have the following physical and performance properties:
    a. IK10 rated for protection against impacts.
    b. IP66 for protection against dust and water.
    c. Auto day/night operation with removable IR cut filter
    d. Low light level operation to 0.3 lux (color) and 0 lux (black and white)
    e. 2D and 3D digital noise reduction
    f. Integral IR illumination, providing effective visibility of 15m at 0 Lux when activated in Black & White mode.
    g. 8 privacy masking regions utilizing polygons
    h. 120dB WDR
    i. One touch (Simple) or manual focus controllable remotely via network.
5. Intelligence and Analytics – The 4K fisheye camera shall have a suite of integral intelligent operations and analytic functions to include:
    a. Motion detection with eight definable detection areas, minimum / maximum object size definition and a learning algorithm that ignores false alarms such as trees and waves on water.
    b. Business intelligence
        1) People counting: Counts people passing virtual lines or staying in zones.
        2) Heatmap: Display frequency of appearance using different color levels.
    c. Detection of logical events of specified conditions from the camera’s video input
        1) camera tamper (scene change)
        2) virtual line
        3) enter/exit
        4) appear/disappear
        5) audio detection
        6) defocus detection

7) digital auto tracking with metadata

6. Interoperability – The 4K fisheye camera shall be ONVIF Profile S and G compliant.
7. The 4K fisheye camera shall possess the following further characteristics:
   a. Built-in web server, accessed via standard browsers including Internet Explorer, Firefox, Chrome & Safari
   b. Micro SD/SDHC/SDXC memory card and NAS recording options, with configurable pre-alarm and post-alarm recording intervals
   c. Bi-directional audio
   d. Alarms and notifications
      1) alarm notification triggers:
         (a) alarm input
         (b) motion detection
         (c) video analytics
         (d) audio detection
         (e) network disconnect
      2) SD card error
         (a) NAS error
      3) available notification means upon trigger:
      4) file upload via FTP and e-mail
         (a) notification via e-mail
         (b) record to local storage (SD/SDHC/SDXC card)
         (c) NAS recording at event triggers
         (d) external output
   e. Pixel Counter available in the plug-in web viewer.
   f. POE capable

2.09 CAMERA TYPE 4 – 3MP IR VANDAL CORNER MOUNTED CAMERA

A. Must meet or exceed the operating characteristics of the Hanwha Techwin America TNV-7010RC.
   1. Provide one (1) 256GB Micro SD/SDHC/SDXC card for each camera to permit temporary edge storage if network connectivity is lost.

B. GENERAL DESCRIPTION
   1. Video Compression and Transmission – The camera shall have the following properties relating to the video signals it produces.
      a. H.265, H.264 and MJPEG compression, each derived from a dedicated encoder and capable of being streamed independently and simultaneously.
         1) H.265 and H.264 – maximum of 30fps at all resolution
         2) MJPEG – maximum of 30fps at all resolution
      b. The camera shall be able to configure up to 10 independent video stream profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
      c. The camera shall be able to configure various resolution selections.
         1) 16:9 aspect ratio: 1920 x 1080, 1280 x 720, 800 x 448, 640 x 360
         2) 4:3 aspect ratio: 2048x1536, 1600 x 1200, 1280 x 960, 1024 x 768, 800 x 600, 640 x 480, 320 x 240,
         3) 5:4 aspect ratio: 1280 x 1024, 720 x 576,
         4) 3:2 aspect ratio: 720 x 480
         5) The camera shall support unicast video streaming up to 20 users.
      d. The camera shall support multicast video streaming
      e. The camera shall be able to configure Dynamic DNS (DDNS). DDNS shall be provided with no additional cost by the manufacturer.

f. The camera shall provide WiseStream Ⅱ, Dynamic GOV and Dynamic fps to efficiently manage bit rate of the video stream and reduce storage.

2. Camera – The camera device shall have the following physical and performance properties:
   a. Anti-ligature design to prevent attachment points.
   b. Anti-ligature design with tamper-resistant mounting to prevent removal of camera for use as a weapon.
   c. IK10+ rated for protection against impacts.
   d. True day/night operation with removable IR cut filter
      1) Low light level operation to 0.3 lux at F2.0 in color mode and 0 lux at F2.0 in black and white mode.
   e. The camera shall be able to produce clear images in highly contrast scenes with multi-exposure wide dynamic range up to 120dB.
   f. The camera shall support digital noise reduction using both 2D and 3D noise reduction technology.
   g. The camera shall be able to configure 32 privacy masking areas with polygons.
   h. The camera shall have the defog feature to remove fogginess of scene which can be triggered automatically from the fog detection event.
   i. The camera shall provide video display on smart phone (iPhone, Android) to adjust viewing angle, rotation and focus.
3. Intelligence and Analytics – The camera shall have a suite of intelligent analytic functions.
   a. Motion detection with 8 definable detection areas with 8 point polygonal zones, and minimum/maximum object size.
   b. Detection of logical events of specified conditions from the camera's video
      1) Tampering, Loitering, Directional Detection, Virtual Line, Enter/Exit, Appear/Disappear
      2) Defocus Detection, Fog Detection, Shock Detection
      3) Motion Detection, Digital Auto Tracking, Face Detection
      4) Audio Detection, Sound Classification
   c. Detection and classification of the following sound.
      1) Scream
      2) Gunshot
      3) Explosion
      4) Crashing glass
4. Interoperability – The camera shall be ONVIF Profile S and G compliant.
5. The camera shall possess the following further characteristics:
   a. Built-in web server, accessed via non-plugin browsers including Google Chrome, IE11, Edge, Mozilla Firefox and Apple Safari.
   b. Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals
   c. NAS recording option with configurable pre-alarm and post-alarm recording intervals
   d. Alarms and notifications
      1) Alarm notification triggers:
         (a) Alarm input
         (b) Motion detection
         (c) Video & Audio analytics
         (d) Network disconnection
      2) Available notification means upon trigger:
         (a) File Upload via FTP and E-mail
         (b) Notification via E-mail
         (c) Local storage (SD / SDHC / SDXC) or NAS recording at event triggers

(d) Alarm output
(e) Handover

e. Pixel Counter available in the web viewer
f. PoE capable
g. IP66, IP6K9K, IK10+ capable

2.10 CAMERA TYPE 5 – 20MP (5MP X 4) MULTI-SENSOR, MULTI-DIRECTIONAL PTRZ CAMERA

A. Must meet or exceed the operating characteristics of the Hanwha Techwin America PNM-9085RQZ.
   1. Provide SBP-317HMW hanging mount pendant cap for each device provided.
   2. Provide SBP-300LMW parapet mount for each device provided.
   3. Provide four (4) 256GB Micro SD/SDHC/SDXC card for each camera to permit temporary edge storage if network connectivity is lost.

B. GENERAL DESCRIPTION
   1. The camera shall provide 360-degree field of view and produce video in quad view mode. It shall also provide digital PTZ along with automated video analytics to allow users to efficiently monitor large visual fields with capability to focus on certain areas when suspicious activity is observed.
   2. Video Compression and Transmission – The camera shall have the following properties relating to the video signals it produces.
      a. H.265, H.264 and MJPEG compression, each derived from a dedicated encoder and capable of being streamed independently and simultaneously.
         1) H.265 and H.264 – maximum 30fps at all resolution
         2) MJPEG – maximum 30fps
   3. The camera shall be able to configure up to 10 independent video stream profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
      a. The camera shall be able to configure various resolution selections.
         1) 2560x1920, 2560x1440, 1920x1080, 1600x1200, 1280x1024, 1280x960, 1280x720, 1024x768, 800x600, 800x448, 720x576, 720x480, 640x480, 640x360, 320x240
      b. The camera shall support unicast video streaming up to 10 users.
      c. The camera shall support multicast video streaming up to 10 profiles
      d. The camera shall be able to configure Dynamic DNS (DDNS). DDNS shall be provided with no additional cost by the manufacturer.
      e. The camera shall provide WiseStream Ⅱ, Dynamic GOV and Dynamic fps to efficiently manage bit rate of the video stream and reduce storage.
         1) Viewing composition: Quad view
   4. Camera – The camera device shall have the following physical and performance properties:
      a. True day/night operation with removable IR cut filter
         1) Low light level operation to 0.11 lux at F1.92 in color mode and 0 Lux for Black and White mode with IR LED on.
      b. The camera shall be able to produce clear images in highly contrast scenes with multi-exposure wide dynamic range up to 120dB.
      c. The camera shall support digital noise reduction using both 2D and 3D noise reduction technology.
      d. The camera shall be able to configure 32 privacy masking areas with polygonal.
      e. The multi-directional camera shall be able to capture high contrast scenes with 120 dB multi-exposure wide dynamic range.
      f. The camera shall provide video display on smart phone (iPhone, Android) to adjust viewing angle, rotation and focus.

g. One touch (Simple) or manual focus controllable remotely via network. The camera shall have motorized varifocal lens.
h. Advanced digital image stabilization with built in gyro sensor. The camera shall be able to measure movements in three axes and accurately enhance images from distortions caused by instability.
i. The camera shall support Pan/Tilt/Rotate through Remote adjustment by 200 cycles.
    1) Intelligence and Analytics – The camera shall have a suite of intelligent analytic functions.
j. Motion detection with 8 definable detection areas with 8 point polygonal zones, and minimum/maximum object size.
k. Detection of logical events of specified conditions from the camera's video
    1) Defocus detection, Directional detection, Fog detection, Face detection, Motion detection
    2) Appear/Disappear, Enter/Exit, Loitering, Tampering, Virtual line
    3) Audio detection
        (a) Interoperability – The camera shall be ONVIF Profile S and T compliant.
        (b) The camera shall possess the following further characteristics:
l. Built-in web server, accessed via non-plugin browsers including Google Chrome, IE11, MS Edge, Mozilla Firefox and Apple Safari.
m. Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals
n. Alarms and notifications
    1) alarm notification triggers:
        (a) Alarm input
        (b) Motion detection
        (c) Video analytics
        (d) Network disconnect
    2) available notification means upon trigger:
        (a) File Upload via FTP and E-mail
        (b) Notification via E-mail
        (c) Local storage (SD / SDHC / SDXC) at event triggers
        (d) External output
o. Pixel Counter available in the web viewer.
p. HPoE capable
q. IP66, IK10, NEMA 4X capable

2.11 CAMERA TYPE 6 – DUAL SENSOR (2MP X 2) CAMERA

A. Must meet or exceed the operating characteristics of the Hanwha Techwin America PNM-7002VD.
    1. Provide SBP-201HMW hanging mount pendant cap and SBP-300WMW1 wall mount for each device provided.
    2. Provide two (2) SLA-2M2802D 2.8mm fixed focal lenses for each camera device.
    3. Provide four (4) 256GB Micro SD/SDHC/SDXC card for each camera to permit temporary edge storage if network connectivity is lost.

B. GENERAL DESCRIPTION
    1. The camera shall provide multi directional view and produce video in various view mode.
    2. Hallway view is available on CH1/2.
    3. Each Channel supports two SD Cards.
    4. It provides one single power supply for all of multi-channels
    5. Video Compression and Transmission – The multi-directional camera shall have the following properties relating to the video signals it produces.

a. H.265, H.264 and MJPEG compression, each derived from a dedicated encoder and capable of being streamed independently and simultaneously
    1) H.265 and H.264 – frame rates to maximum 60fps (60Hz) / 50fps(50Hz) at all resolution
    2) MJPEG – frame rates to maximum 30fps (60Hz) / 25fps (50Hz) at all resolution
b. The multi-directional camera shall be able to configure up to 10 independent video stream profiles with differing encoding, quality, frame rate, resolution, bit rate, and other video settings.
c. The multi-directional camera shall have four lenses and each lens shall provide the following resolutions.
d. 1920x1080, 1280x1024, 1280x960, 1280x720, 1024x768, 800x600, 800x448, 720x576, 720x480, 640x480, 640x360, 320x240
e. The camera shall support unicast video streaming up to 20 users.
f. The camera shall support multicast video streaming up to 10 profiles.
g. The camera shall be able to configure Dynamic DNS (DDNS). DDNS shall be provided with no additional cost by the manufacturer.
h. The camera shall provide WiseStream Ⅱ, Dynamic GOV and Dynamic fps to efficiently manage bit rate of the video stream and reduce storage.

6. Camera – The multi-directional camera device shall have the following physical and performance properties:
    a. IK10 rated for protection against impacts.
    b. IP66 for protection against dust and water.
    c. The camera shall be able to produce clear images in highly contrast scenes with multi-exposure wide dynamic range.
    d. The camera shall support digital noise reduction using both 2D and 3D noise reduction technology.
    e. 32 privacy masking regions utilizing polygons
    f. Supporting digital image stabilization, the camera shall be able to measure movements in three axes and accurately enhance images from distortions caused by instability.
7. Intelligence and Analytics – The multi-directional camera shall have a suite of integral intelligent operations and analytic functions to include:
    a. Motion detection with 8 definable detection areas with 8 point polygonal zones, and minimum/maximum object size.
    b. Detection of logical events of specified conditions from the camera's video
        1) Defocus detection
        2) Fog detection
        3) Directional detection
        4) Motion detection
        5) Appear/Disappear
        6) Enter/Exit
        7) Loitering
        8) Tampering
        9) Virtual line
        10) Face detection
8. Interoperability – The camera shall be ONVIF Profile S and T compliant.
9. The multi-directional camera shall possess the following further characteristics:
    a. Built-in web server, accessed via standard browsers including Internet Explorer, Firefox, Chrome & Safari
    b. Micro SD/SDHC/SDXC memory card options, with configurable pre-alarm and post-alarm recording intervals

c. Alarms and notifications
    1) alarm notification triggers:
        (a) Analytics
        (b) Network disconnect
    2) available notification means upon trigger:
        (a) File Upload via FTP and E-mail
        (b) Notification via E-mail
        (c) Local storage (SD / SDHC / SDXC) or NAS recording at event triggers
d. Pixel Counter available in the web viewer.
e. PoE capable
f. This device has been verified using STP cable. The use of appropriate GND grounding and STP cable is recommended to effectively protect your product and property from transient voltage, thunderstroke, communication interruption.

2.12 CAMERA TYPE 7 – 2MP SMALL FORM FACTOR WIDE ANGLE FLAT CAMERA

A. Must meet or exceed the operating characteristics of the Hanwha Techwin America XNV-6012.
    1. Provide one (1) 256GB Micro SD/SDHC/SDXC card for each camera to permit temporary edge storage if network connectivity is lost.

B. GENERAL DESCRIPTION
    1. Video Compression and Transmission – The camera shall have the following properties relating to the video signals it produces.
        a. H.265, H.264 and MJPEG compression, each derived from a dedicated encoder and capable of being streamed independently and simultaneously
            1) H.265 and H.264 – frame rates to maximum 60 fps at all resolution
            2) MJPEG – frame rates to maximum 30 fps at all resolution
        b. The camera shall be able to configure up to 5 independent video stream profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
        c. The camera shall be able to configure various resolution selections
            1) 16:9 aspect ratio: 1920 x 1080, 1280 x 720, 800 x 448, 640 x 360
            2) 4:3 aspect ratio: 1280 x 960, 1024 x 768, 800 x 600, 640 x 480, 320 x 240,
            3) 5:4 aspect ratio: 1280 x 1024, 720 x 576,
            4) 3:2 aspect ratio: 720 x 480,
        d. The camera shall be able to stream multiple video stream type using unicast protocol
        e. The camera shall support multicast and unicast video streaming
        f. The camera shall be able to configure Dynamic DNS (DDNS).
        g. Smart Codec, Dynamic GOV, and Dynamic fps to efficiently manage bitrate of the video stream.
    2. Camera – The camera device shall have the following physical and performance properties:
        a. Dustproof and waterproof
        b. IK10 rated for protection against impacts.
        c. True day/night operation with removable IR cut filter
            1) Low light level operation to 0.04 lux(F2.0) in color mode and 0.04 lux(F2.0) in black and white mode
        d. The camera shall support digital noise reduction using both 2D and 3D noise reduction technology.
        e. Configurable a privacy masking regions utilizing a 32-point polygon
        f. The camera shall provide video display on smart phone (iPhone, Android) to adjust viewing angle, rotation and focus.
    3. Intelligence and Analytics – The camera shall have a suite of integral intelligent operations and analytic functions to include:

a. Motion detection with eight definable detection areas with 8 point polygonal zones, minimum / maximum object size.
b. Detection of logical events of specified conditions from the camera's video input
    1) camera tamper (scene change)
    2) loitering
    3) directional detection
    4) fog detection
    5) virtual line
    6) enter/exit
    7) appear and disappear
    8) audio detection
    9) face detection
    10) digital auto tracking
    11) sound classification with external MIC
    12) defocus detection
    13) motion detection with metadata

4. Interoperability – The camera shall be ONVIF Profile S and G compliant.
5. The camera shall possess the following further characteristics:
    a. Built-in web server, accessed via standard browsers including Internet Explorer, Firefox, Chrome & Safari
    b. Dual edge recording slot like Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals
    c. NAS recording option with configurable pre-alarm and post-alarm recording intervals
    d. bi-directional audio
    e. Alarms and notifications
        1) alarm notification triggers:
        2) motion detection
            (a) video analytics
            (b) network disconnection
        3) available notification means upon trigger:
            (a) file upload via FTP and e-mail
            (b) notification via e-mail
            (c) record to local storage (SD card) or NAS storage
            (d) external output
        4) dptz preset
    f. Pixel Counter available in the web viewer.
    g. PoE capable including heater by PoE

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

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

3.02 WIRING

A. Wiring Method: Install cables in raceways unless otherwise indicated.

B. Wiring in publicly accessible areas or areas that can be exposed to the exterior elements shall be concealed in a proper conduit enclosure to the extent necessary to fully protect the wire

from weather or vandalism.

1. Except raceways are not required in accessible indoor ceiling spaces and attics.
2. Except raceways are not required in hollow gypsum board partitions.

C. Conceal raceways and wiring except in unfinished spaces.

D. 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.

E. Label wiring at each end with machine generated labeling tape. No hand written labels shall be permitted.

F. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

G. For LAN connection and fiber-optic and copper communication wiring, comply with TAA requirements for Telecommunications Systems Infrastructure

H. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.03 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Provide and install all equipment, software, materials, and labor to include system programming for a completely operational video management system described herein an included on the Project Drawings. These specifications and project drawings are complementary in describing the design intent of the security video management system.

B. Install cameras and other appurtenances level and plumb for a high quality, workman-like installation.

C. Cameras shall be securely mounted to back box in a manner to meet the requirements set forth for typical corrections applications, flush with no grab points.

D. Utilize tamper resistant screws in locations accessible by prison population.

E. All equipment requiring users to log on using a password to be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed. Contractor shall implement all camera manufacturer’s cyber security recommendations and configurations, following industry best practices per the Hanwha Cyber Hardening Guide

F. If applicable, set PTRZ pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.

G. Install power supplies and other auxiliary components at control stations unless otherwise indicated.

H. Aim cameras as directed by engineer and/or owner.

I. Configure SD card edge storage on each device to meet the needs of the owner.

J. Program camera system head end. Provide unique on-screen camera identification for all cameras with the following nomenclature.

K. Program all system analytics and AI system parameters as directed by the engineer and/or owner.

3.04 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 and forward results to the engineer and/or owner.

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

D. Tests and Inspections:
   1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
   2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
      a. Verify proper fields of view, operation of auto-iris lenses, maximize WDR and day/night settings for the environment.
      b. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
      c. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
      d. Set and name all preset positions; consult Owner's personnel.
      e. Set sensitivity of motion detection.
      f. Set, test and correct as needed, all analytical and/or AI parameters per the owner and/or engineer.
      g. Connect and verify responses to alarms.
      h. Verify operation of control-station equipment.

E. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
   1. 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.

F. Video surveillance system will be considered defective if it does not pass tests and inspections. Warranty will only begin after official system acceptance.

G. Prepare test and inspection reports.

3.05 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
   1. Check cable connections.
   2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
   3. Adjust all preset positions; consult Owner's personnel.
   4. Clean lenses or housings.
   5. Recommend changes to cameras, lenses, FOV, and associated equipment to improve Owner's use of video surveillance system.
   6. Make system changes to recording parameters, camera settings, FOV’s that can be made without the need to purchase additional equipment and/or software.

7. Provide additional and/or refresher system training to the owner (max 4-hours) on system operations, functionality and administrations.
8. Provide a written report of adjustments and recommendations.

3.06 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment for a period of 8 hours on-site.

3.08 TRAINING

A. Contractor shall provide minimally 4-hours of system administrator training and up to three (3) 2-hour sessions of user training to the owner and designated personnel in the full operations and maintenance of the video management system.

B. The training shall assure the owner has a comprehensive understanding and basic level of competence of the system.

C. As a follow up, the contractor shall provide up to two (2) additional hours of training in the following weeks to assure owner competence to any questions or issues that have been experienced once turned over to the owner.

END OF SECTION

SECTION 28 2313
VIDEO SURVEILLANCE CONTROL AND MANAGEMENT SYSTEMS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SUMMARY

A. Section includes:
   1. Video Surveillance Control and Management Systems (VMS).

B. Related Sections:
   1. Section 28 23 00 – Video Surveillance Cameras.
   2. Section 27 10 00 - Structured Cabling
   3. Section 28 40 00 - Control Systems for Security
   4. Division 28 - Security System

1.03 SUBMITTALS

A. Submit under provisions of Contract Documents.

B. Product Data:
   1. Manufacturer's data, user and installation manuals for all equipment and software programs including computer equipment and other equipment required for a complete VMS.

C. Shop Drawings:
   1. System device locations on architectural floor plans.
   2. Full schematic of system including wiring information for all devices.

D. Closeout Submittals:
   1. User manuals.
   2. Parts list.
   3. System device locations on architectural floor plans.
   4. Wiring and connection diagrams.
   5. Maintenance requirements.

1.04 QUALITY ASSURANCE

A. Manufacturer shall have a minimum of ten (10) years' experience in the manufacture and design of VMS products.

B. Installer:
   1. Minimum of five (5) years' experience installing VMS products.
   2. All installation, configuration, setup, programming and related work shall be performed by technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.

1.05 DELIVERY, STORAGE AND HANDLING

A. Comply with requirements of Contract Documents.

B. Deliver materials in manufacturer's original, unopened, undamaged containers with original identification labels.

C. Protect stored materials from environmental and temperature conditions following the manufacturer's instructions.

D. Handle and operate products and systems according to the manufacturer's instructions.

1.06 WARRANTY

A. Provide manufacturer's warranty covering three (3) years for replacement and/or repair of defective equipment.

1.07 MAINTENANCE

A. Make ordering of new equipment for expansions, replacements and spare parts available.

B. Provide factory direct technical support to the installing firm.

C. VMS system manufacturer shall offer online, self-paced training for installers, system administrators and users. Online training shall be accessible from VMS system manufacturer's website at any time.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Basis of design for Video Management System (VMS): Lensec.

B. Requests for substitution will be considered. The Contractor shall submit supporting documentation clearly describing functionality and features to meet or exceed the products named. Substitutions shall be submitted as per Contract Documents.

2.02 SYSTEM SUMMARY

A. The Video Management System (VMS) shall provide smart-client based Internet Protocol (IP) Video for integrated security management. The VMS shall be browser based, allowing for the management of and viewing of any configured camera located at any facility from any network-connected computer. The VMS shall also provide for viewing of any recorded video from any configured camera at any facility using any standard network-connected computer and using any standard internet browser such as, but not limited to, Google Chrome, Internet Explorer (IE), Edge, Firefox, Safari, etc.

B. The VMS shall leverage HTML5 standards for live video streaming, archive video playback, and general application delivery via standard web browsers.

C. The use of smart clients shall not require the installation of software code from the VMS provider company on the client viewing device and shall be an intuitive graphical system that is web based benefiting the user by facilitating quick learning of the system and reducing the training time required to become proficient in its use.

D. User access to the system shall require a single log-on credential. The system shall recognize an authentic credential and grant user access to all devices and modules he or she has permission to use regardless of the number of servers hosting those devices and modules in the security network.

E. Operation of the system shall require using either a touch screen or commonly available mouse and keyboards. The VMS client shall be fully able to access all modules and features offered by the VMS. Access and functionality shall be limited only by the permissions assigned to any given user by the system or delegated administrator(s).

F. The VMS shall offer communications and collaboration features enabling users to exchange messages and share views with others on the security network.

G. The VMS shall include a panel to display alerts from other users on the security network and from integrated devices manufactured by other companies. Some examples include, but are not limited to, video camera manufacturers, access control manufacturers, RFID manufacturers and video analytics manufacturers.

H. The VMS shall include a navigation tool bar on its client enabling users to move with a single mouse click from one module to another module.

2.03 LICENSES

A. The Video Management System shall be offered in appropriate editions or licensed versions. There shall be an Express version, Standard version, and an Enterprise version. Advancement from a lesser version to a greater version shall be allowed by a simple license key adjustment.

2.04 VIDEO MANAGEMENT GENERAL REQUIREMENTS

A. Microsoft .NET Requirements:
   1. Microsoft .NET Framework 4.x is a Free download from Microsoft and is a requirement of the VMS System and must be installed on both the server and on all clients for proper operation.

B. Database Requirements:
   1. Microsoft SQL Server (2012, 2014, 2016, 2017, or 2019) is a requirement and must be installed on the server. Either the Microsoft SQL Server Express which may be downloaded from Microsoft at no charge or the complete version of SQL Server Standard or Enterprise may be utilized with the VMS.

C. Adobe Acrobat:
   1. Adobe Acrobat version X or equivalent PDF reader should be installed in order to view and read the installed VMS Manuals.

D. Microsoft IIS (Internet Information Services):
   1. Microsoft IIS version 7.0 (or greater) is a requirement and must be installed on the server for proper operation of the clients.

E. Internet Browser:
   1. There must be a current Internet Browser such as Google Chrome version 57 or greater, Internet Explorer version 11 or greater, Mozilla FireFox version 54.0 or greater.

2.05 SERVER HARDWARE, STORAGE AND SERVICES REQUIREMENTS

A. Current commercially available server-grade Operating Systems (OS) shall be approved to operate the VMS server-based applications and services. Including:
   1. The VMS Software shall be designed to operate as a server on Windows 2019 Server.
   2. The VMS Software shall be designed to operate as a server on Windows 2016 Server.
   3. The VMS Software shall be designed to operate as a server on Windows 2012 R2 Server.
   4. The VMS Software shall be designed to operate as a server on Windows 10.

B. The VMS System server software shall utilize a high performance, multi- threaded, application engine design. This shall allow multiple tasks to be executed at the same time and is required.

C. The VMS software shall operate consistently on stand-alone or integrated host and storage platforms from recognized IT industry suppliers. Hardware independence is a requirement.

D. The VMS System shall support multiple storage options which may consist of SATA, SCSI, iSCSI, for video storage., including:
   1. DAS (Direct Attached Storage)
   2. NAS (Network Attached Storage)
   3. SAN (Storage Area Network)

E. The VMS software shall be installed by a certified VMS Integrator, or when necessary the VMS manufacturer.

F. All services may be installed on a single stand-alone server or distributed among multiple servers.

2.06 ARCHIVE/STREAMING SERVER HARDWARE AND SOFTWARE

A. Processor: 2.4 GHz (x64 Processor) or 1.3GHz (Dual Core).

B. Memory: Minimum 8 GB RAM.

C. Available Disk Space: Minimum: 320 GB

D. OS Partition (if applicable): Minimum 40 GB

E. Windows 2012 Server or above (Recommended Windows 2012 R2 Server).

F. Internet Information Services 6 or greater.

G. MIME Types: .xap and .xaml files.

H. Microsoft .NET Framework 4.6.

I. Microsoft SQL Database Server 2014/2016 (Express/Standard/Enterprise).

J. All services may be installed on a single stand-alone server or distributed amongmultiple servers.

2.07 DATABASE SERVER HARDWARE AND SOFTWARE

A. Processor: 1.0 GHz

B. Memory: Minimum 4 GB RAM

C. Available Disk Space: Minimum: 320 GB

D. Windows 2012 Server or above (Recommended Windows 2012 R2 Server).

E. Microsoft SQL Database Server 2014/2016 (Express/Standard/Enterprise).

F. All services may be installed on a single stand-alone server or distributed among multiple servers.

2.08 WEB SERVER HARDWARE ARE AND SOFTWARE

A. Microsoft IIS 7.0 or higher is needed to host VMS as an Application.

B. All services may be installed on a single stand-alone server or distributed among multiple servers.

2.09 STORAGE – VIDEO ARCHIVES AND LONG TERM STORAGE

A. The amount of storage space necessary is based on the desired number of days required for video storage, the format of video to be stored, resolution, image complexity, Frames Per Second (FPS), if the video to be stored will be continuous, motion or event-based, the number of events daily etc. The storage may be SAN (Storage Array Network), NAS (Network Attached Storage), DAS (Direct Attached Storage), or Fiber attached storage.

1. For this project, 90 days of storage at 15 FPS is required. Only motion events shall be stored.

2.10 CLIENT SOFTWARE REQUIREMENTS

A. Current commercially available Operating Systems (OS) shall be approved to operate the VMS client application. Including:

1. The VMS Software shall be designed to operate as a browser-based client on Windows 7 Home and Professional editions.
2. The VMS Software shall be designed to operate as a browser-based client on Windows 8.1 Desktop edition.
3. The VMS Software shall be designed to operate as a browser-based client on Windows 10.
4. The VMS Software shall be designed to operate as a browser-based client on Windows 2012 Server.
5. The VMS Software shall be designed to operate as a browser-based client on Windows 2012 Server.

6. The VMS Software shall be designed to operate as a browser-based client on the Apple OS X operating system.

B. Microsoft .NET Requirements:
   1. The VMS Product must incorporate the features of Microsoft .NET Framework 4 or must be capable of using Microsoft .NET Framework 4.x or greater is required.

C. Database Requirements:
   1. The VMS client shall not require a database engine for operation of the VMS.

D. Adobe Acrobat:
   1. Adobe Acrobat Reader version X or equivalent PDF reader should be installed in order to view and read the VMS product manuals.

2.11 CLIENT HARDWARE RECOMMENDATIONS

A. Processor: 2.4 GHz (x64 Processor) or 1.3GHz (Dual Core).

B. Memory: Minimum 4 GB RAM.

C. Available Disk Space: Minimum: 10 GB

D. Display: SXGA (1280 x 1024) or higher resolution.

E. Windows 7 or above (Recommend Windows 10).

F. Mac OSX or higher (Recommended OSX Lion).

G. Internet Explorer 11.0

H. Google Chrome 54.0 and above (Recommended 57.0).

I. Mozilla Firefox 52.0 and above (Recommended 54.0).

2.12 GRAPHICAL USER INTERFACE (GUI)

A. All VMS System functionality including viewing video and hearing audio files whether live or archived must be available to the user through a properly authenticated smart client (web client). A smart client will utilize an internet browser such as IE, Firefox, or Chrome to communicate with the server or servers hosting the VMS System, its services, its functionality, its modules and its archives. The requirement of a rich client or thick client platform shall be deemed non-compliant.

B. The VMS shall have cross browser interoperability. Separate users may use different internet browsers on the same VMS System simultaneously with full functionality including sharing video and inter-application collaboration. There shall be no requirement that client software from the VMS manufacturer be installed on the client device.

C. The VMS software shall operate on stand-alone or integrated host and storage platforms from recognized IT industry suppliers. The ability of a systems integrator or user to install the VMS System on commercial off-the-shelf (COTS) hardware is a requirement. The VMS software may be installed by a certified VMS Integrator, the VMS Manufacturer or a customer.

D. The VMS System shall fully support drag and drop design features.

E. The VMS shall have the ability to run as a desktop client (Out-of-Browser Experience) with no requirement to install a thick client dedicated software package for operation or administration/configuration.

F. The VMS System design shall permit the uninhibited use of touch screen technology as well as the use of traditional mouse based user interaction.

G. The VMS Software shall incorporate the use of a browser icon “favicon” o differentiate the application from other web/browser tabs.

H. The VMS shall provide consistency through-out by utilizing a Top Navigation Bar providing certain information and controls applicable to the system in general. The controls in the Top Navigation Bar remain constant and are available in each module.

I. The VMS shall provide an intuitive method to search globally for any content contained, User Tags, Extractions, Cameras, Maps, multi-view presets, sequences etc.

J. The VMS shall have a provision for the user to select their own default Module when logging into the VMS.

K. The VMS shall have a tool for monitoring active streaming connections within the VMS via a webpage for troubleshooting and debug purposes.

2.13 WELCOME AND LOGIN MODULE

A. The VMS shall upon logon authentication present the User with a Welcome screen permitting the selection of password controlled modules to include a training module utilizing video training segments.

B. The VMS shall require all Users / Operators to be authorized and verified for login. Passwords are Case Sensitive.

C. The VMS shall have the ability to generate an authenticated pass-through login credential to access the VMS from 3rd party software or resources without requiring an additional login.

D. The VMS shall have the ability to integrate with Active Directory.

E. The system shall have an ability to create a custom message for users logging into the VMS. This message can be a one-time acceptance by the user, or persistent for each access attempt to the software. The message(s) may be custom tailored for each permission group and multiple messages may be prioritized or ranked for sequential viewing and acknowledgement.

2.14 TRAINING MODULE

A. The VMS System shall include a video and text based Training Module. The Training Module shall contain video instruction on how to operate various features and functions.

2.15 MAPS MODULE

A. The VMS shall include an interactive map module. Maps displayed in the module may display icons representing various devices integrated into the VMS. Device icons shall be responsive to mouse interactions (rollover or hover, clicking, etc.) that will display camera views or allow camera views to be acted upon in some other useful functions such as dragging them to a docking area or clicking on them to display in another module. Map locations of hosted devices shall be visually identifiable in the Map Module. In addition, the map or maps integrating the individual device shall be coordinated with and viewable from a function selection in an overlay displayed in the Camera View module enabling the user to quickly view the map or maps hosting the camera being viewed. The Map Module shall contain a user controlled pop-up overlay enabling selections for quickly navigating through map collections. It is mandatory that the selections offered in the overlay include one-click return to the last map viewed, one-click return to the top map in the map collection hierarchy, the ability to display layers, a zoom in, zoom out, pan control and user selectable display listing all maps with a search field to quickly locate a particular map. Lastly, the Map Module shall have a Camera Dock area where camera views can be dragged and dropped into for continuous display as the user navigates through various maps. Docked camera views must be able to be opened in the live Camera Viewer by clicking a button. Camera views placed in the Camera Dock shall remain there and thus viewable by the user whenever he or she returns to the Map Module or until the user clears the views by clicking a Clear button in the Camera Dock.

B. The VMS shall provide the ability to navigate multiple maps with dynamic pan and zoom on each graphic. The Maps Module shall provide an overlay navigational tool bar for navigating

multiple maps. The overlay shall include a dynamic zoom capability, the ability to click buttons for getting to the last map or for quickly navigating to the top map in the collection, and a method to display layers within maps.

C. The VMS shall provide a method of easily importing standard graphics files such as BMP, JPG, and PNG for use as a map.

D. The VMS shall have a method to support multiple floors of a single building/site the Maps Module allows you to select which map you wish to view, and to easily switch among the different maps. There are two methods that may be available to you to select the map you wish to view.

E. The VMS shall have the ability to add definable layers to any map. The VMS shall allow these layers to be hidden based on user permissions.

F. The Maps Module shall provide an interface for “At a Glance Overview” of an end user’s geographic footprint. In addition, maps may use symbols to represent pictorially a single site, building, building floor, or an entire enterprise system. Further, the Map Module shall offer capability to create icons that interact with cameras managed by the VMS System in a manner that provides motion alert indication and real-time pop-up views of the cameras represented by the icons.

G. The VMS Software shall provide the ability to globally group items across all maps to be shown as distinct layers that may be toggled on or off.

H. The VMS shall have an ability to integration to dynamic map tools showing street names and site facilities including the ability to search for sites and addresses.

I. The VMS shall have an Integration with OpenStreet Maps®

J. The VMS shall have a Camera Dock area where camera views can be dragged and dropped into for continuous display as the user navigates through various maps. Docked camera views must be able to be opened in the live Camera Viewer by clicking a button. Camera views placed in the Camera Dock shall remain there and thus viewable The Camera Dock feature shall permit a user to drag and drop cameras from one or more maps into a common area (Camera Dock) for viewing. This permits a user to have the ability to view cameras from multiple locations (buildings) on multiple subnets simultaneously.

K. The VMS shall have an ability for users to navigate to maps associated to cameras within the dock from an associated map rapid call-up button.

L. The VMS shall have an ability to load all visible cameras from a map to the camera dock.

M. The VMS shall provide every user the capability to select their own default map when logging in to the VMS.

N. The VMS shall incorporate the ability to overlay a coordinate grid for visually pinpointing an area of a map.

O. The VMS shall have an ability to load all cameras from a map with one click from the Camera Dock interface.

P. The VMS shall have the ability to measure between points and area within Live Maps (Maps Module).

2.16 CAMERA VIEWER MODULE

A. The VMS Software shall have the capability to create, save, and display a layout of cameras.

B. The VMS shall display a Camera View Header displaying the name of the camera and the date and time of the image being viewed. If viewing a Multi-View, each View in that Multi-View will have its own Camera View Header. A visual “highlight” will indicate to the user the camera has been selected for control with the Camera Viewer Control Panel or the Archive Video Control

Panel. The header will also be used as the handle to drag and drop camera views to and from other containers to enhance/optimize layouts.

C. The VMS shall provide a Camera Viewer module which provides live video viewing, enabling an operator to monitor one or more live views.

D. The VMS shall have selectable multi-view layouts available as templates for viewing live video streaming. Each template can be populated using drag and drop techniques and then saved using a unique name for ease of future recall by an operator.

E. The VMS Shall have the ability for the user to "Fill" or "Fit" the viewing area by not constraining video feeds to maintain defined aspect ratios.

F. The VMS shall provide the ability for custom defined multiple live streaming camera view arrangements using 4:3 or 16:9 ratios with several pre-defined templates for easy and fast viewing configurations.

G. The VMS shall allow users the capability to create, save, and display a definable layout of any set of cameras across the enterprise. The configured Multi-View Presets may be marked as Private, indicating they may only be viewed by the user who configured it. If the Preset is not marked as Private, then it shall be considered Public and available to all users.

H. The VMS Shall have the ability for selected cameras with multiple resolution attributes to stream at a size appropriate for larger and smaller container sizes, making streaming more efficient and reducing bandwidth consumption.

I. The VMS shall provide a control to allow for selecting or switching a camera field-of-view in a camera container, where an operator can switch the current camera View(s) in the Multi-View layout. The operator can change the Arrangement, and switch camera positions within the Arrangement. The user shall be able to list cameras by map location, thumbnail image or text listing which may be filtered using a search parameter.

J. The VMS shall permit Pan-Tilt-Zoom (“PTZ”) cameras which can be rotated left and right (“panned”) and up and down (“tilted.”) The camera can also be zoomed between wide-angle and telephoto views. Placing your cursor in the PTZ Camera View screen provides you with access to the on-screen Joystick Emulator. Options for "Click to Center" where the view would be centered on a mouse click, or "Click to Zoom" whereby the view would be focused and zoomed to an area of interested defined by outlining a box on the camera view, shall be available.

K. The VMS shall display a unique interactive control for control of a PTZ camera using a sphere graph in the upper left corner of the video display.

L. The VMS shall permit the mimicking of Pan-Tilt-Zoom (“PTZ”) functions on fixed cameras whereby users may digitally zoom into a Field-of-View (FOV) and then rotate the FOV left and right (“pan”) and up and down (“tilt.”).

M. The VMS shall have the ability to lock a PTZ in position, preventing another user from moving the PTZ without first over-riding the lock action.

N. The VMS shall have the ability to set a PTZ stop coordinate or location. This function shall apply to those PTZ cameras having the capability of having location presets and/or tour functionality.

O. The VMS shall provide a method of configuring PTZ camera presets as a Camera Tour configuration.

P. The VMS shall have the ability to set a PTZ "Home" position and set a time value for returning the PTZ to home automatically.

Q. The VMS shall provide the ability to set a timeout for PTZ to return to home.

R. The VMS shall have the ability to optionally set PTZ presets for configuration on the camera (at the edge).

S. The VMS shall allow PC/USB joysticks (including Playstation and Xbox game controllers) for controlling Pan/Tilt/Zoom functionality of compatible cameras.

T. The VMS shall provide users with an intuitive method of Tagging Video from a live camera or archived view for quick follow up retrieval. Tagging will allow for private or public viewing based on permissions.

U. The VMS shall provide the user the ability to capture a digital still image (snapshot) from a single camera, from multiple cameras, or from all cameras contained within a multi-view layout.

V. The VMS shall provide the user the ability to capture a digital still image (snapshot) from a single camera, from multiple cameras, or from all cameras contained within a multi-view layout.

W. The VMS shall provide a visible overlay of the analytic event's metadata via an image snapshot.

X. The VMS shall have the ability to auto focus compatible cameras from within the camera viewer container.

Y. The VMS Shall provide an On-Screen-Display button for manually extracting/exporting live video without motion or an external event trigger.

Z. The VMS shall have an ability to create ad hoc neighboring camera views by quickly associating together all of the views from cameras in a geographical or logical association which may be recalled from any camera programmed with a one-click action.

AA. The VMS shall have the ability to make any camera view container full-screen with a single-click action.

BB. The VMS shall provide the ability to auto-focus compatible cameras from within the VMS.

CC. The VMS shall have the ability to stream live audio with a video feed.

DD. The VMS shall provide a graphical method for a User to define a view of cameras which can be displayed in a sequential manner with definable time periods for each sequence stop.

EE. The VMS Software shall have a default camera sequence of all cameras the user has access to, enabling the user to quickly scan cameras one after another in a one-up configuration.

FF. The VMS shall allow for any camera view to be opened from a live view into an archive viewer for event timeline analysis.

GG. The VMS shall allow for any camera view to be opened from a live view into an administration view for configuration of the camera.

HH. The VMS shall have the ability to locate the position of a camera on a map from a live view interface.

II. The VMS shall provide the ability to review video frame-by-frame both forward and reverse.

JJ. The VMS shall provide the ability to rewind and fast-forward control recorded video at upto 64x speeds from the Camera Viewer container of any camera.

KK. The VMS shall provide the ability, while in archive playback mode within the camera viewer module, to associate cameras together in custom multi-view arrangement of a logical group for quick display of "neighbor" cameras or devices.

LL. The VMS shall provide a capability within the User Interface to annotate cameras that are Out-of-Service for planned / remedy maintenance or pre-staging of future installation cameras to alert the user of a known out-of-service condition.

MM. The VMS shall have an ability to view multi-view arrangements without pixel space or borders between containers.

NN. The VMS shall have the ability to instantly review 10 seconds back.

2.17 ARCHIVE MODULE

A. The VMS shall have an Archives module allowing an operator to quickly locate and play back archived video. The Archive module shall provide the functionality for timeline-based archive retrieval, event and archive integration, downloading and sharing archived video, and tagging archived footage.

B. The VMS shall have a streaming archive video player. The player must provide a means of quickly searching video based on timeline, specific time, and events. The Archive video player must provide speed control, virtual PTZ control as well as forensic search capability.

C. The VMS shall provide support to view live video and archived video, for cameras supporting Motion -JPEG video.

D. The VMS shall provide support to view live video and archived video, for cameras supporting MPEG-4 video as well as cameras supporting MPEG video.

E. The VMS shall provide support to view live video and to record video, using cameras supporting the H.264 video format.

F. The VMS shall provide support to view live video and to record video, using cameras supporting the H.265 video format.

G. The VMS shall have the ability to playback multiple archived or recorded video streams simultaneously.

H. The VMS shall have the ability to record or archive audio synchronized with video.

I. The VMS shall provide the ability to combine an external audio source (secondary IP source) with a camera.

J. The VMS shall have the ability to stream audio out via an on-screen control within the camera control of the VMS. The feature shall utilize the PC microphone and audio-output on selected cameras.

K. The VMS shall provide the ability to monitor Archived video in a full-screen view.

L. The VMS shall provide a visible overlay of the analytic event's metadata during playback.

M. The VMS shall have the capability for a user to make an Extract of a video clip Public or Private through the use of a check-box marked Private while creating the Extract. Private Extracts shall not be available for viewing by other Users.

N. The VMS shall maintain a list of Extracted/Exported video designating Video files that have been extracted (available for download) by users.

O. The VMS shall have the capability to download extracted video in a file format which can be viewed using the standard Microsoft Media Player or other common players such as VLC.

P. The VMS shall contain a player capable of playing recorded video, and extracted video internally to the VMS.

Q. The VMS shall have an ability to download multiple camera extractions into a single playback file as a video collage.

R. The VMS shall have the capability of scanning and searching through multiple image extractions.

S. The VMS shall have a Fast Find control accessible on the Camera Overlay Bar allowing a User to define an area of the video to search motion on Motion-JPEG recording archives.

Additionally there shall be a method to define the as being High, Medium, or Low motion.

T. The VMS shall have a Fast Find control accessible on the Camera Overlay Bar allowing a User to define an area of the video to search motion on Image recorded archives. Additionally there shall be a method to define the as being High, Medium, or Low motion.

U. The VMS shall provide a Dynamic timeline allowing a User to dynamically modify the time-period, time interval, and displayed time for archived video being viewed.

V. The VMS shall provide the user the ability to flag or mark sections of time for exemption from the normal archive deletion routines thus locking or protecting archives within their normal storage array.

W. The VMS shall have an ability to scroll/seek the archive timeline with image previews.

2.18 ADMINISTRATION MODULE

A. The VMS shall contain an Administration module which shall contain all configurable parameters of the VMS such as Users, Cameras, Maps, etc. The Administration module shall be password controllable, all configured parameters must be capable of being saved, as well as reported on for modifications, date and time created, as well as date created.

B. The VMS shall provide a method to copy / duplicate configurable objects listed under the Administration section. The duplicate items shall be easily identifiable and shall allow parameters to be uniquely modified.

C. The VMS shall be capable of displaying all Users currently logged on to the VMS, the client IP address, the date and the time the User logged on. Alternatively, a User's active session may be terminated by another User with the proper password control.

D. The VMS shall allow the ability to print configuration parameter tables in a variety of formats including .pdf, and .xls.

E. The VMS shall provide an intuitive Graphical User Interface for adding users. This interface shall allow an existing user to be copied with all pertinent settings to create/add a new user. The newly added user shall be clearly indicated permitting the new user to be uniquely modified and stored for future usage.

F. The VMS shall allow unlimited users to added to the system.

G. The VMS shall employ User Groups be created and multiple Users may be assigned to a group, permitting permissions to be efficiently administrated for all users assigned to a common group.

H. The VMS shall maintain a Profile for each User, the Profile shall contain customizable preferences to be utilized each time the User Logs in to the system. The preferences shall determine the user's language preference, theme, startup screen, default camera layout, camera header visibility, PTZ navigation preference, and other information.

I. The VMS shall have an ability to designate within a user profile the display of events via popup notification in a window for rapid viewing.

J. The VMS shall provide every user the capability to select their own default arrangement when logging in to the VMS.

K. The VMS shall allow each user the ability to define default timeline start time and interval.

L. The VMS shall provide a user preference option of a black empty background or a background populated by the camera image snapshot (from archives).

M. The VMS shall provide the ability to allow multiple logins by one user. Also allows for this permission to be denied to users/groups.

N. The VMS shall provide a complete audit trail report of Users, concerning their actions and history showing when the action was performed.

O. The VMS shall provide administrators with an at-a-glance "last-login" reporting and audit of users who have logged into the VMS.

P. The VMS shall have the ability to restrict users access to the VMS during selected schedules.

Q. The VMS shall provide the ability to edit multiple user profiles at once (bulk edit).

R. The VMS shall allow an unlimited number of cameras to be added to the system.

S. The VMS shall provide a Graphical User Interface (GUI) for the purpose of configuring/modifying cameras for administration purposes. This Graphical User Interface must all a User to add/modify/delete cameras.

T. The VMS shall have an ability to address cameras via IP address or hostname.

U. The VMS shall contain a list of the World Timezones and their Offset from GMT (Greenwich Mean Time) permitting selection of the appropriate Timezone where utilized in configuration of cameras etc.

V. The VMS shall have an ability to rotate a camera stream via configuration.

W. The VMS shall provide an interface for adding select custom camera attributes for on-the-fly integration to uncommon cameras or camera features.

X. The VMS shall have an ability to Export and Import custom camera model configurations across different systems or customers.

Y. The VMS shall have an ability to set a value selection for compression quality (bitrate) if allowed per camera model for streaming bandwidth regulation.

Z. The VMS shall allow users to select default / preferred aspect ratio for cameras.

AA. The VMS shall utilize the camera security credentials for viewing and administration purposes. This permits the camera credentials to be changed and the VMS made aware of the new credentials for security purposes.

BB. The VMS shall have an ability to push camera passwords generated in the VMS to the camera.

CC. The VMS shall allow an ability to use anonymous camera access.

DD. The VMS shall provide the ability to define an alternate location should configured archive locations become inaccessible. This "Failover" location would be utilized only if no other archiving paths could be found.

EE. The VMS shall have an ability to designate a primary archive storage area and a secondary archive storage area which may act independently using individual camera streams for archiving at individual parameters (FPS, Resolution) over varying storage settings.

FF. The VMS shall allow the ability to set parameters for edge motion archiving for select models.

GG. The VMS shall utilize a sortable list of the configured cameras in order to make it easier for a user to find a specific camera.

HH. The system shall have the ability to export a excel template for adding and inserting new camera records in bulk.

II. The VMS shall utilize dynamic storage for archiving video to leverage available capacity across one or multiple drive volumes.

JJ. The VMS shall have an ability to archive a second continuous archive at a configurable frame per second on all motion-based archiving.

KK. The VMS shall have the ability to directly open the camera interface from the camera setup screen. This permits direct configuration and testing of the camera without utilizing the VMS.

LL. The VMS shall allow for direct snapshot capture in an installation verification screen.

MM. The VMS shall have an ability inside of camera configuration to test the camera stream status.

NN. The VMS shall allow the User to define an area of interest for motion detection by the display of a user definable box on the screen to assist in setting the area of interest.

OO. The system should have the ability to define priority levels for different motion detection zones.

PP. The VMS shall have an ability to archive on motion via a server-based motion analytic for cameras using the M-JPEG codec.

QQ. The VMS shall provide the ability to leverage edge device motion detection algorithms for event archiving and alerts.

RR. The VMS shall have an ability to annotate reference information for support items per each camera object.

SS. The VMS shall provide administrators and systems integrators the ability to add cameras directly from the network using a discovery tool. (Applicable to cameras that are ONVIF-Profile S compliant).

TT. The VMS shall have an ability to define the IP Range (subnet) for discovery.

UU. The VMS shall provide the ability in configuration to customize Frames Per Second (FPS), Motion Sensitivity, and Overlay controls for any custom camera.

VV. The VMS shall allow for bulk editing of multiple cameras at once.

WW. The VMS shall allow for custom string handling for archive types.

XX. The VMS shall provide the ability to adjust the motion sensitivity.

YY. The VMS shall allow for a custom setting designation for the camera overlay height (by pixels).

ZZ. The VMS shall allow for a custom setting designating the motion difference ratio.

AAA. The VMS shall provide the ability in configuration to customize Frames Per Second (FPS), and Overlay controls for cameras using a video codec.

BBB. The VMS shall allow for designating a clip length (by minute) for archived Video (MPEG4 or H264).

CCC. The VMS shall have an ability to pull/import recordings from an SD card either from the camera or directly from the SD card itself.

DDD. The VMS shall provide User Settings in the User Administration area, permitting startup and default settings to be applied to each User account when they sign in to the system.

EEE. The VMS shall maintain the recording store location for video on a per camera basis. Recording paths for manual extractions or real-time extractions will be configurable and maintained by system settings.

FFF. The VMS shall have an ability to automate a redistribution of archives from one location in store to remaining active locations within the archive store.

GGG. The VMS shall have an ability to check for unhealthy or missing files on disk.

HHH. The VMS shall have the ability to custom define the number of seconds to pre- buffer when performing motion detection.

III. The VMS shall have the ability to custom define the amount of time when a service recognizes a camera stream as not connected (also known as a Timeout interval).

JJJ. The VMS shall have the ability to modify the default training URL so that a custom path and custom application may be applied if necessary.

KKK. The VMS shall have the ability to custom configure intervals and thresholds for health monitoring on Cameras, Servers, External Systems, and Drive Information.

LLL. The VMS shall have an ability to configure a connection with an IP-based video wall system.

MMM. The VMS shall have the ability for an SQL database backup routine to be initiated and/or scheduled from within the VMS.

NNN. The VMS shall provide a method of uploading, saving, applying, and displaying those custom Icons representing devices such as cameras, buildings, etc.

OOO. The VMS shall provide the ability to define stand alone or distributed servers and administer their respective services from any instance of the VMS.

PPP. The VMS shall allow the association of custom defined "Keywords" with video and events allowing search by Keywords for faster retrieval of events and video.

QQQ. The VMS shall provide lists of Tag Keywords and Tag Categories to be defined and stored for later use to provide consistency of Keywords and Categories of Tags associated with events and video.

RRR. The VMS shall provide a method of uploading standard graphics files such as bmp, pcx, jpg, and dwg files for use as custom map files and to have Icons representing devices dropped on the graphic to be used as a Maps containing Camera or other device Icons.

SSS. The VMS shall provide an intuitive drag-and-drop interface module for layout and design adjustments to map files including desired zoom parameters and optional layer and device placement options.

TTT. The VMS shall provide (within the Map design tool) a snapshot preview (or live stream) of the camera as it is being placed into the map.

UUU. The VMS shall have an ability to utilize keyboard shortcuts to position cameras (fine-tune) on a map.

VVV. The VMS shall provide a predefined set of icons for use as camera icons in pre- selected colors and designs. The VMS shall have a means of importing new icons in the event those provided are not acceptable.

WWW. The VMS shall have the ability to add sites (or buildings) for map and camera association.

XXX. The VMS shall have an ability to design custom shapes for placement on a map.

YYY. The VMS shall allow unlimited sites and/or servers to be added to the system.

ZZZ. The VMS shall provide the ability to setup and configure globally grouped items across all maps to be shown as distinct layers that may be toggled on or off.

AAAA. The VMS shall maintain each User and their activities while they are logged in for use to create User Audit Trail reports.

BBBB. The VMS shall have multiple language support including: English, Arabic, Spanish, Portuguese, French and Russian.

CCCC. The VMS shall utilize a wizard during installation. The wizard shall utilize graphical techniques to make installation user friendly.

DDDD. The VMS shall be able to be updated or upgraded from version to version via a software wizard utility without requiring a re-installation or re-programming of existing data.

EEEE. The VMS shall be affixed to the site or enterprise via a distinct software license. This license may be amended via the user interface based on an increase in needed functionality or scope of the project.

FFFF. The VMS shall provide an End-User License Agreement (EULA).

GGGG. The VMS shall provide a configuration area within administration to monitor and administer actions performed on Windows-based Services such as Starting, Stopping, and restarting these services.

HHHH. The VMS Shall have the ability to maintain an image snapshot of all events and also the ability to schedule and purge retained images of events from the database at a desired number of days.

IIII. The VMS shall have an ability for setting the refresh time in seconds of the snapshot reference image per camera.

JJJJ. The VMS shall allow cameras to be grouped together administratively for faster search and call-up in the selection of cameras in the camera viewer or archive modules.

KKKK. The VMS shall provide a means of defining custom or special function PTZ controls for each camera added to the system.

LLLL. The VMS shall allow for ONVIF PTZ standard configuration.

MMMM. The VMS shall contain a list of cameras by brand and model which have been tested and certified for use with the VMS and shall contain a method for adding a new camera to the list. The camera model list shall be utilized for the command structure to communicate with a specific camera model while the IP address shall be configured for each specific camera added to the database.

NNNN. The VMS shall have an ability to set pre-defined responses to alarm/alert acknowledgements.

OOOO. The VMS shall have the ability to modify the user-interface with private labeling options.

PPPP. The VMS shall have an ability to determine password policy qualifiers (character limit and type) for users and camera devices.

QQQQ. The VMS shall have a schedule interface tool designed for event/action parameters but that will also customize further the times to record, archive, search for motion or other items.

RRRR. The VMS shall have an ability to configure multi-sensor / multi-channel cameras.

SSSS. The VMS shall have an ability to schedule various parameters of recording on camera during selected schedules.

TTTT. The VMS shall have an ability to manage imported video information within the Administration module.

UUUU. The VMS shall have a configurable setting to allow for the auto expiration of users who have not accessed the system in "n" days.

VVVV. The VMS shall have an ability to check and automate creation of a PowerShell script for removal of any archive location for any folders or files that are not cataloged in the database as valid archive files.

2.19 INTEGRATION MODULE

A. The VMS shall have an ability within the Integrations section of Administration for naming and associating connectors (3rd-party controlling or reference objects) with devices for use in alerts and workflows.

B. The VMS shall have an ability within the Integrations section of Administration for administering types of 3rd-party controllers and connectors.

C. The VMS shall have an ability within the Integrations section of Administration for naming and associating 3rd party security devices with cameras for use in alerts and workflows.

D. The VMS shall have an ability within the Integrations section of Administration for naming and associating analytic rules with cameras for use in alerts and workflows.

E. The VMS shall have an ability within the Integrations section of Administration for naming and associating RFID Antennas with cameras for use in alerts and workflows.

F. The VMS shall have an ability to integrate with Intelligent Vehicle Undercarriage Scanner (IVUS) from Gatekeeper.

2.20 FLEET ADMINISTRATION

A. The VMS shall have an ability to create vehicle objects for association of cameras to inputs and metadata.

B. The VMS shall have an ability to associate fleet vehicles with transmitting stations objects for organizational purposes.

2.21 WORKFLOWS ADMINISTRATION

A. The VMS shall have a component matrix for logical association of objects, triggers, conditions and actions that allow for integration of user actions, scheduled parameters and/or physical or logical inputs into on-screen display actions or other notification alerts.

B. The VMS shall have an ability to initiate/trigger a programmable action (via workflow routine) based a defined an event from multiple cameras selected at once.

C. The VMS shall have an ability to initiate/trigger a programmable action (via workflow routine) based a defined an event from a configured control list.
   1. The VMS shall have the ability to initiate/trigger a programmable action (via workflow routine) based a defined event such as an input, video analytic, or system message.

D. The VMS shall have the ability to initiate/trigger a programmable action (via workflow routine) based on a specific or recurring time.
   1. The VMS shall have an ability to initiate/trigger a programmable action (via workflow routine) based a defined an event from a camera.
   2. The VMS shall have an ability to initiate/trigger a programmable action (via workflow routine) based a defined an input event from a camera.
   3. The VMS shall have an ability to initiate/trigger a programmable action (via workflow routine) based a defined an event from a configured door device.
   4. The VMS shall have an ability to initiate/trigger a programmable action (via workflow routine) based a defined an event from a configured behavioral analytic device.
   5. The VMS shall have the ability to initiate/trigger a programmable action (via workflow routine) based on an action button.
   6. The VMS shall have an ability to initiate/trigger a programmable action (via workflow routine) based an defined an event from a configured RFID device.
   7. The VMS shall have an ability to trigger via workflow a pop-up stream of a camera as an action response.

E. The VMS shall have an ability to notify externally of the VMS (such as email) on trigger-able (alarm/alert) conditions defined in a workflow.

F. The VMS shall have an ability to notify a user or group via an audible alert as an action from a configured workflow.

G. The VMS shall have an ability for the VMS to enhance normal camera configurations (FPS and Resolution) to a changed state on trigger-able (alarm/alert) conditions defined in a workflow.

H. The VMS shall have an ability to move to a PTZ preset as a result of a workflow on trigger-able (alarm/alert) conditions defined in a workflow.

I. The VMS shall have an ability to configure device output actions as part of a workflow.

J. The VMS shall have an ability to automate a manual recording (Real-Time Extraction) for a period of defined time based upon a triggered event as part of a workflow.

K. The VMS shall have an ability to configure a user interface actions as part of a workflow. These actions may be configured for autonomous action or if desired, require user prompting.
   1. The VMS shall have an ability to configure an action (of a workflow) to navigate user(s) or group(s) to the Maps module and select a desired map for immediate view.
   2. The VMS shall have an ability to configure an action (of a workflow) to navigate user(s) or group(s) to the Camera Viewer module with a selected camera view/arrangement.
   3. The VMS shall have an ability to configure an action (of a workflow) to navigate user(s) or group(s) to the Archive module and select a desired camera view and pre-event time parameter for viewing that camera arrangement.
   4. The VMS shall have an ability to configure an action (of a workflow) to navigate user(s) or group(s) to the Welcome module.
   5. The VMS shall have an ability to configure an action (of a workflow) to navigate user(s) or group(s) to an external URL in a new browser tab or window.
   6. The VMS shall have an ability to configure an action (of a workflow) to navigate user(s) or group(s) to the Reports module and select a desired report for immediate view.
   7. The VMS shall have an ability to configure an action (of a workflow) to navigate user(s) or group(s) to the Administration module and select a desired sub category for immediate view.

L. The VMS shall have an ability to define scheduling conditions for enabling a workflow which consists of defined triggers and customized actions.

2.22 CUSTOM ACTION BUTTON

A. The VMS shall have an ability to add user-defined buttons that can be utilized as a trigger for workflow-based actions. The button may be customized by the configuration user in both text and graphic icon.

2.23 SIDE PANEL AND EVENT VIEWER

A. The VMS shall have a Side Panel as the system’s communications center. It consists of the Actions Container and the Events Container. The Actions Container enables you to Send Messages and Share Views with other users. The Events Container enables you to receive information about, view, and respond to Motion events, Door and RFID alerts, System events, Tags, Image Extractions, incoming Messages and Shared Views.

B. The VMS shall provide a collection of tools and controls providing the ability to dynamically share messages, views, and extractions with other users.

C. The VMS shall have an intuitive method for a user to "Share View" with one or more additional Users permitting quick collaboration allowing multiple Users to simultaneously view the same camera(s).

D. The VMS shall have an ability to push a share view to a user’s workstation on command.

E. The VMS shall provide a means for Users to quickly send a message to another User permitting ease of joint collaboration and cooperative efforts.

F. The VMS shall have an ability to "one-click" restricted-access the video surveillance system enabling access for only select users (based on permission assignments).

G. The VMS shall have an ability to import video files (.mp4, .mov) from an external source such as a mobile phone, tablet, or web-camera. The imported videos may be associated to a selected device and managed within the archive timeline for comparison against other camera objects during an investigation or search.

H. The VMS shall provide an information panel capable of being sorted/searched/grouped by Time, Date, Object, criteria and being able to be expanded or collapsed at User discretion.

I. The VMS shall be capable of detecting motion events in a user defined area of the camera view for each camera configured and functioning on the system.

J. The VMS shall be able to define multiple areas of interest for motion detection.

K. The VMS shall have a pop-up window allowing a user to select for preview a Motion event, in the situation where multiple motion events are detected at or near simultaneously the user must be able to select the event to be previewed.

L. The VMS shall display System Alerts Side Panel Event Notification area. These Alerts shall notify the User of System, Camera, or Service actions and/or messages.

M. The VMS shall provide Camera Status via a visual up/down indicator in the System Events Panel.

N. The VMS shall provide Service Status via a visual up/down indicator in the System Events Panel.

O. The VMS shall have an audible alert tone which shall be capable of being turned On or Off (disabled) by User preference. Selectable via a checkbox accessible on the "Settings" menu selected on the "Navigation Bar".

P. The VMS shall have the ability to track alert acknowledgement by user/date as well as modify event to mark as active for additional follow up. Marked active event transactions are also tracked by user and date.

Q. The VMS shall provide message alerts for system events for user-to-user communication.

R. The VMS shall permit a User to share his view / video with one or more additional Users dynamically and shall provide an Alert message with an optional tone to notify a User that a view / video has been shared with them. This shall all be accomplished dynamically with in the VMS.

S. The VMS shall provide an information panel to review current and past users' share views.

T. The VMS shall provide users with an intuitive method of "Tagging" video, events, or cameras. These tags shall be retrievable via global search or through a navigable information panel.

U. The VMS shall provide a quick preview of Tagged Events through a pop-up from the events panel by hovering the mouse over the Tagged Event object in the Side Panel view.

V. The VMS shall have an ability to mark / highlight an area of interest within a tagged event.

W. The VMS shall have a configurable pop-up notification for alerts.

X. The VMS shall have an adjustable pop-up viewing window for streaming camera views from any module upon workflow alert.

Y. The VMS shall have an ability to schedule vehicle incident imports from fleet recorders.

2.24 BEHAVIORS

A. The VMS shall display details concerning extracted Video, such as Extraction name, Category, Keywords, Camera name, Date, Start Time, Duration, Status, Whom created the Extraction,

Associated tag, and a Description.

B. The VMS shall allow for behavior-based event tracking such as video analytics.

C. The VMS shall have the ability to incorporate 3rd-party behavior-based video analytics.

D. The VMS shall provide a quick preview of integrated video analytic events through a pop-up from the events panel by hovering the mouse over the Behaviors object in the Side Panel view.

E. The VMS shall have the ability to incorporate 3rd-party behavior-based video analytics from Agent Vi.

F. The VMS shall have the ability to incorporate the Cross-Line Analytic behavior from Axis Communications.

G. The VMS shall have an ability to read license plates and convert to text data using optical character recognition.

H. The VMS shall have an ability to incorporate facial recognition results from CyberExtruder Aureus 3D Facial Recognition application.

I. The VMS shall have an ability to send images for analysis from Zensors enhanced analytics.

J. The VMS shall have an ability to have a map associated to a behavior event transaction table.

K. The VMS shall allow for the display of edge analytics events.

L. System shall support the ability to support edge motion detection through ONVIF event listener.

2.25 CAMERAS

A. The VMS shall support by default configuration camera models for the following manufacturers:
   1. ACTi
   2. Advidia

B. American Dynamics
   1. Anson
   2. Avigilon
   3. Axis Communications
   4. Bosch
   5. BST Security
   6. Canon
   7. Cisco
   8. Dahua Technologies
   9. D-Max
   10. Dynacolor
   11. Flir
   12. Hanwha (formerly Samsung)
   13. HikVision
   14. Hunt
   15. Huawei
   16. Ikegami
   17. IntelliNet
   18. Interlogix
   19. JVC
   20. King
   21. LeLin
   22. Lorex
   23. Micropower

24. Mobotix
25. Moog
26. OpenEye
27. Panasonic
28. Pelco
29. Robotina
30. Siemens
31. Sony
32. Stardot

C. Toshiba
1. TruVision
2. Vicon (IOinVision)
3. Vivotek

D. The VMS shall support analog encoders for the following manufacturers:
1. ACTi
2. Axis Communications
3. Bosch
4. Hanwha
5. HIK Vision
6. Pelco

E. The VMS shall support the capability for audio streaming for following manufacturers:
1. Axis Communications
2. BST Security
3. Dahua Technology
4. Hanwha
5. HIK Vision
6. Mobotix
7. Vicon (IOinVision)

F. The VMS shall support bi-directional audio streaming for the following manufacturers:
1. Axis Communications
2. BST Security
3. Dahua Technology
4. HIK Vision
5. Vicon (IOinVision)

G. The VMS shall support edge-archiving for the following manufacturers:
1. Axis Communications
2. BST Security
3. Dahua Technology
4. HIK Vision

H. The VMS shall support edge-based Motion Detection alerts for the following manufacturers:
1. Axis Communications
2. BST Security
3. Vicon (IOinVision)

I. The VMS shall support camera Input/Output alerts for the following manufacturers:
1. Axis Communications
2. Dahua Technology
3. HIK Vision

4. Hanwha

J. The VMS shall support camera GOP/GOV rate adjustments for the following manufacturers:
   1. Axis Communications

K. The VMS shall support camera ANPR alerts for the following manufacturers:
   1. Nedap Identification Systems

2.26 ACCESS CONTROL

A. The VMS shall have a visual alert within the events panel, annotating an alert from a related door alarm.

B. The VMS shall allow for video call-up integration via web interface with DNA Fusion access control from Open Options.

C. The VMS shall have an ability to pull (as events) Access Control transactions from S2 Enterprise Access Control System by S2 Systems.

D. The VMS shall have an ability to pull (as events) Access Control transactions from S2 Netbox Access Control System by S2 Systems.

E. The VMS shall have an ability to pull (as events) Access Control transactions from System Galaxy's Access Control System by Galaxy Control Systems.

F. The VMS shall have an ability to communicate via API for event transactions with System Galaxy by Galaxy Control Systems.

G. The VMS shall have an ability to integrate with actions and events with System Galaxy using SignalR communications.

H. The VMS shall have the ability to lock, unlock and pulse doors from System Galaxy by Galaxy Control Systems.

I. The VMS shall have an ability to import door devices into the administration configuration of PVMS from the System Galaxy Access Control database.

J. The VMS shall have an ability to pull (as events) Access Control transactions from BadgePass Access Control Systems.

K. The VMS shall have the ability to lock, unlock and pulse doors from BadgePass Access Control Systems.

L. The VMS shall have an ability to pull events from a MorphoTrack reader.

M. The VMS shall have an ability to pull (as events) Access Control transactions from TDSI Access Control System by Time & Data Systems International Ltd.

N. The VMS shall have an ability to control (lock, unlock, pulse) door controls within AccessIt! Access Control from RS2.

O. The VMS shall have an ability to pull events using WinDSX Events Cast API.

P. The VMS shall have an ability to pull events from CredoID Access Systems.

Q. The VMS shall have an ability to import doors/readers from CredoID Access Systems.

2.27 RFID INTEGRATION

A. The VMS shall have the ability to receive events from RFID readers.

B. The VMS shall have the ability to call-up or associate cameras in archives with an RFID event.

C. The VMS shall have an ability to receive events and alerts with Impinj RFID connectors and devices.

2.28 SPECIALITY INTEGRATION

A. The VMS shall have an ability to receive events from JVA Technologies Electric Fence.

B. The VMS shall have an ability to receive events and video from CommPort's Under Vehicle Surveillance System.

C. The VMS shall have an ability for event detection from Sicurit HyperPower Perimeter detection.

D. The VMS shall have an ability to silence Sicurit alarms.

E. The VMS shall have support for Planar Video Wall distribution events.

F. The system shall have an ability to add syslog connections for SNMP communication.

G. The VMS shall have an ability to receive server health alerts from Razberi appliances.

H. The system shall have the ability to pull events from Bosch G-Series Intrusion Detection Panels.

2.29 TAPE STORAGE INTEGRATION

A. The VMS shall have the ability to coordinate archives with long term archive systems leveraging disk and tape solutions.

B. The VMS shall have the ability to configure archiving service settings including the ability to disable thumbnail generation when accommodating archival retrieval from tape.

2.30 FLEET MODULE

A. The VMS shall have an ability to integrate vehicle surveillance from one or multiple video sensors into a centralized video management software.

B. The VMS shall have an ability to manage multiple fleet vehicles/devices centrally for viewing video across a timeline of events and including the ability for vehicle incident export.

C. The VMS shall have a visual display of the signals meta-data from the selected vehicle.

D. The VMS shall have an ability to track of vehicle's speed during transit route in association with video

E. The VMS shall have a Live Maps view with vehicle path from displayed meta- data

F. The VMS shall have an ability to mark/flag/bookmark a specified time within a recording using a physical input on the fleet vehicle.

G. The VMS shall have a visual display of the vehicle's door position when open.

H. The VMS shall have a visual display indicator of the vehicle's brake when engaged.

I. The VMS shall have a visual display indicator of the vehicle's turn signals when engaged.

J. The VMS shall have a visual display indicator of the vehicle's warning signal when active.

K. The VMS shall have a visual display indicator of the vehicle's stop arm when engaged.

L. The VMS shall have an ability to auto calculate and tag vehicle idle time in the fleet module event timeline

M. The VMS shall have an ability to identify camera(s) from an assigned vehicle for associated event cataloging and subsequent review for playback and/or extraction with or without signals data.

N. The VMS shall have an ability to remotely turn of and detect status of a vehicle's network video recorder.

O. The VMS shall have an ability to incorporate GIS metadata and display over live mapping software for vehicle tracking.

P. The VMS shall have an ability to print a route driven over a period of time

Q. The VMS shall have an ability to extract vehicle incident video data.

2.31 REPORTING MODULE

A. The VMS shall provide the ability to launch data reports within the application.

B. The VMS shall have an ability to save custom report filters and configurations

C. The VMS shall have an ability to run a report show all Users and their last activity.

D. The VMS shall provide exportable reports for event acknowledgement / responses by users.

E. The VMS shall have the ability to filter RFID data and run printable RFID transaction reports.

F. The VMS shall provide exportable reports for a line crossing analytic on Axis cameras

G. The VMS shall provide the ability to run a report showing all cameras and archiving locations.

H. The VMS shall have a report to illustrate the relationship between integration connectors and devices.

I. The system shall have the ability to run reports illustrating associated schedules with cameras.

J. The VMS shall be able to run a report showing cameras marked as Out-of- Service.

K. The VMS shall have a printable report that shows the image snapshot of each camera in the system for assessing camera image quality, focus and field-of-view.

L. The VMS shall be able to run a report show all Groups and inherent permissions of each group for reference. This report shall be exportable to PDF or Excel formats.

M. The VMS shall provide an exportable status report of current camera status along with support reference information.

N. The VMS shall have an ability to run a report show all Users with access to a list of cameras.

O. The VMS shall have an exportable status report of all active camera's archiving statistics including: Camera Name, Model, IP Address, Archiving Server, Store Location, Oldest Archive Date, Newest Archive Date, Missing Dates, Archive Span, Archive Schedule, Archive Codec, Retention, Motion %, Storage per Day, Total Storage Used, Archive Lock Status.

P. The VMS shall provide a report showing archiving storage deficits based on archiving targets, actual archive span, and storage capacity.

Q. The VMS shall have an ability for filtering of report for status changed since a selected date value

R. The VMS shall provide an exportable status report of current server status along with support reference information.

S. The VMS shall have an ability to report on statistical information in graphical format of archive storage utilization per day.

T. The VMS shall have a report showing historical transaction log of workflow events initiated by trigger with date/time.

U. The VMS shall have an area inside of the reports module for launching the fleet reports

V. The VMS shall have an ability to generate health reports on camera health of remote fleet devices

W. The system shall have a report showing the current status of vehicles configured in the Fleet Management Module.

X. The VMS shall have a report illustrating license plate image of plate and vehicle with date/time

2.32 ADMINISTRATION SERVICE

A. The VMS shall provide a service that monitors and checks drives for the right utilization; checks how much free space on the drive(s), and subsequently purges old archives or moves them to a different offsite location. It shall also be responsible for importing and ensuring user synchronization between Active Directory and the VMS.

B. The VMS shall manage archives using a service-based management tool. The management shall be based on a first-in-first-out (FIFO) routine and shall incorporate configurable parameters such as targeted archive days and minimum allowable free space for the volume/drive.

C. The VMS shall provide the ability to view events, transactions, errors from the VMS Administration Service in an event log within Microsoft's Administrative Tools.

D. The VMS shall have an ability to configure fail-over services on alternative servers for increased system redundancy

2.33 ARCHIVING SERVICE

A. The VMS shall have an Archive Service which provides for; archiving image and video streams from system cameras, handling image extraction requests from users and create archives/extractions accordingly, as well as managing live recording requests from users to capture camera video streams and encode them using H.264/MPEG-4 codec for optimal quality/size.

B. The VMS shall have an ability to extract video from archived recordings to a segregated location on the network that will not be overwritten by the software. This video may also be downloaded externally as a copy for permissioned users.

C. The VMS shall have an ability to add metadata of a server generated overlay with camera name, date/time onto video extractions.

D. The VMS shall have an ability to edit or refine extractions via editing start and end times thereby creating a second "trimmed" extraction in addition to the original.

E. The VMS shall maintain a location on a local or shared volume for storing captured thumbnail images as a visual reference in the dynamic camera selector and in the administration of cameras user interface.

F. The VMS shall be capable of recording camera streams in a H.264 format.

G. The VMS shall be capable of recording camera streams in a Motion-JPG format.

H. The VMS shall be capable of recording camera streams in a MPEG (video) format.

I. The VMS shall be capable of recording camera image frames for time-lapse or segmented recording.

J. The VMS shall be capable of creating video extraction copies from any archived video pulling a lesser number of frames thereby creating a subsequent time-lapse video from general security recordings.

K. The VMS shall have an ability to create privacy masks for video extractions.

L. The VMS shall provide the ability to view events, transactions, errors from the VMS Archiving Service in an event log within Microsoft's Administrative Tools.

M. The VMS shall have an ability that allows a user to determine the condition for removing archives (per camera) based on number of target days achieved, based on drive space limitations, or a storage maximum.

N. The VMS shall allow for remote archive management on all servers even when the network connectivity is in a degraded state preventing access to the central database.

2.34 HEALTH MONITOR SERVICE

A. The VMS shall have a Health Monitor Service which functions to check if system cameras defined in the VMS are up and running. If not, the service will notify the user about the offline status of the camera in question. The Service will also generate health report related to cameras, servers and other system components.

B. The VMS shall provide the ability to view events, transactions, errors from the VMS Health Systems Service in an event log within Microsoft's Administrative Tools.

C. The VMS shall provide an ability for the system to detect and report via email health status exceptions such as non-responsive services, cameras offline, or excessive database size growth.

D. The system shall have the ability to detect and report via email when the reserve space on an archive store location is reached.

E. The VMS shall have the ability for the system to detect and report via email health status exceptions if a store location path is inaccessible.

F. The system shall have a configurable setting for capping memory (RAM) utilization by a managed service. Upon reaching the threshold the service will be restarted and an alert message will be logged/sent.

G. The VMS shall have an ability for the system to detect and report via email health status exceptions if network bandwidth exceeds 95%.

H. The VMS shall provide an alert on failure to copy archives in an distributed interlink configuration.

2.35 STREAMING SERVICE

A. The VMS shall provide a service that acts as an intermediary agent between the VMS and system cameras; it is mainly responsible for handling the streams and passing them to the system. It is also responsible for streaming the archives that are created using Archiving Service.

B. The software shall provide the ability to stream camera feeds from across a LAN/WAN over multiple subnets in a distributed server architecture.

C. The VMS shall designate a Streaming Server to handle a client request for live video in Motion-JPEG format when direct connection is unavailable.

D. The VMS shall designate a Streaming Server to handle a client request for live video via H.264 protocols when direct connection is unavailable.

E. The VMS shall be capable of streaming archived/recorded video to one or multiple client station by use of a streaming service.

F. The VMS shall have an ability to stream within a container supported by HTML5 compliant web browsers including Apple iOS using WebRTC.

G. The VMS shall provide the ability to view events, transactions, errors from the VMS Streaming Service in an event log within Microsoft's Administrative Tools.

H. The VMS shall support a diagnostics page for assessing streaming performance.

2.36 EXTERNAL SERVICE

A. The VMS shall have a service communicating independent packages from the main VMS system to act as an intermediary communication agent between the VMS and 3rd party software/hardware applications (RFID, IDS, Access Control, etc).

B. The VMS shall provide the ability to view events, transactions, errors from the VMS External Systems Service in an event log within Microsoft's Administrative Tools.

2.37 ANALYTIC SERVICE

A. The VMS shall have a service communicating independent packages from the main VMS system to act as an intermediary communication agent between the VMS and 3rd party Video Analytic applications.

B. The VMS shall provide the ability to view events, transactions, errors from the VMS Analytic Service in an event log within Microsoft's Administrative Tools.

2.38 WEB SERVICE

A. The VMS web server shall run as a Window's Service. This service shall be running as long as the server is booted and has started Windows. It shall not require the user to be logged in.

B. The VMS shall provide the ability to view events, transactions, errors from the VMS Web Service in an event log within Microsoft's Administrative Tools.

C. The VMS Shall have an ability to link multiple remote independent sites (Interlink) for integrated client management.

D. The VMS shall have an ability to support SSL on Interlink configuration deployments.

E. The VMS shall support LDAP Signing.

F. The VMS shall have an ability to configure fail-over web services on alternative servers for increased system redundancy.

2.39 SERVICE API (SDK)

A. The VMS shall provide the ability to render live streaming or archive playback at a set date/time in a controlled browser window of the VMS based upon an application programmable interface (API) call.

B. The VMS shall have an ability to operate a 64-bit SDK service for 3rd-party interconnectivity with Perspective VMS.

2.40 SYSTEM HELP

A. The VMS shall have integrated Help files and by clicking the Help control the user will gain access to the VMS Help resources and documentation, and also allows the operator to view the version information for the application.

B. The VMS shall support both tool tips as well as extended tool tips to provide additional information.

C. The VMS shall list its version number and details in an About section for support reference.

D. The VMS shall provide support contact information from the User Interface

2.41 SQL DATABASE

A. The VMS shall have via an SQL database the ability for information to be uploaded and viewed via the user-interface at any time in real-time.

B. The VMS Software shall be designed to operate using a Windows SQL Server 2008 database.

C. The VMS Software shall be designed to operate using a Windows SQL Server 2008 Express database with up to a 10 GB size maximum.

D. The VMS Software shall be designed to operate using a Windows SQL Server 2012 database.

E. The VMS Software shall be designed to operate using a Windows SQL Server 2012 Express database with up to a 10 GB size maximum.

F. The VMS Software shall be designed to operate using a Windows SQL Server 2014 database.

G. The VMS Software shall be designed to operate using a Windows SQL Server 2014 Express database with up to a 10 GB size maximum.

H. The VMS shall have an ability to automatically monitor and maintain a user- defined database size so that it does not exceed a defined limitation (example: 10 GB for SQL Express Version)

2.42 VMWARE SUPPORT

A. The VMS shall have the ability for the application to be installed and maintained on a VMware instance.

2.43 SECURITY MANAGEMENT SYSTEM INTEGRATION

A. The VMS shall integrate with the Security Management System outlined in Division 28 Contract Documents for video call-up. Provide all equipment as required for a complete system.

2.44 SECURITY MONITORS

A. Provide security monitors of sizes as indicated on the Contract Documents. This includes, but is not limited to monitors, mounting equipment, peripheral devices, wiring, and other equipment required for a complete system.

2.45 CABLING INFRASTRUCTURE, SECURITY NETWORK SWITCHES AND UNINTERRUPTIBLE POWER SUPPLIES

A. The entire VMS system, including security network switches at the MDF and IDFs, shall be backed up by UPSs in accordance with specification Section 27 1000 'Structured Cabling' and Contract Documents.

B. Provide security network switches as required in accordance with specification Section 28 4000 'Control Systems for Security' and Contract Documents.

C. Provide cabling infrastructure in accordance with specification Section 27 1000 'Structured Cabling' and Contract Documents.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine area to receive devices and notify any adverse conditions affecting installation or subsequent operation.

B. Do not begin installation until unacceptable conditions are corrected.

3.02 PREPARATION

A. Protect equipment from damage during construction.

3.03 INSTALLATION

A. Install equipment in accordance with manufacturer’s instruction at locations indicated on the floor drawing plans.

B. Perform installation with qualified service personnel.

C. Install devices in accordance with the National Electrical Code or applicable local codes.

D. Ensure selected location is secure and offers protection from accidental damage.

3.04 FIELD QUALITY CONTROL

A. Test snugness of mounting screws of all installed equipment.

B. Test proper operation of all VMS devices.

C. Determine and report all problems to the manufacturer’s customer service department.

3.05 ADJUSTING

A. Make proper adjustment to video system devices for correct operation in accordance with manufacturer's instructions.

3.06 DEMONSTRATION

A. Demonstrate at final inspection that the VMS is functioning properly.

END OF SECTION

SECTION 28 3116
FIRE ALARM SYSTEM

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

B. Related Specification Sections:
   1. Section 050527 – Security Metal Fasteners
   2. Section 083111 – Access Doors
   3. Section 260500 – Common Work Results for Electrical.
   4. Section 260519 – Low Voltage Electrical Power Conductors and Cables.
   5. Section 260526 – Grounding and Bonding for Electrical Systems.
   6. Section 260529 – Hangers and Supports for Electrical Systems.
   7. Section 260533 – Raceways and Boxes for Electrical Systems.
   8. Section 260553 – Identification for Electrical Systems.
   9. Division 28 - Security System

C. Reference Symbols:
   1. All device symbols are defined by the appropriate symbol schedules. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location.
      a. Contractor shall coordinate exact locations with all architectural drawings, reflected ceiling plans, furniture plans, mechanical and electrical drawings as well as all affected trades prior to submittal of any shop drawings.

1.02 SUMMARY

A. This Section includes basic design requirements for the installation of a complete Addressable Fire Alarm System as specified herein and as shown on the plans; to be wired, connected, and left in first class operating condition. Include sufficient control panel(s), remote annunciator(s), remote transponder panels (DGP), manual stations, automatic fire detectors, smoke detectors, alarm notification appliances, wiring terminations, electrical boxes, and appurtenances as well as all necessary material, labor and integration with ancillary systems for a complete operating fire alarm system as indicated on the Contract Documents and/or as herein specified.

B. The contractor shall furnish all labor, equipment, materials, software and the performance of all programming in connection with the installation of a new point addressable Fire Alarm System as shown on the drawings and as herein specified

C. The fire alarm system shall comply with requirements of 2013 NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The complete installation shall conform to the applicable sections of NFPA-70 National Electrical Code (Article 760). The system shall be electrically supervised and monitor the integrity of all conductors.

1.03 REFERENCES

A. In addition to all requirements of this specification, the following codes and standards listed below shall also form a part of this specification. The system shall comply with the latest adopted standards.
   1. National Fire Protection Association (NFPA):
      a. 13 Sprinkler Systems
      b. 70 National Electrical Code
      c. 72 National Fire Alarm Code
      d. 90A Installation of Air-Conditioning and Ventilating Systems

e. 92A Recommended Practice for Smoke-Control Systems
f. 101 Life Safety Code
g. 731 Installation of Electronic Premises Security Systems.

2. Local and State Building Codes:
   a. International Building Code IBC –2003
   b. International Mechanical Code IMC –2003
   c. ICC/ASMEI A117.1 Accessible and Usable Buildings and Facilities
   d. ICC/ASME A17.1 Safety Code for Elevators and Escalators
3. All requirements of the Authority Having Jurisdiction (AHJ).

1.04 APPROVALS:

A. The system and all components shall have the proper listing and/or approval from the following nationally recognized agencies:
   1. UL-Underwriters Laboratories Inc
   2. FMG- Factory Mutual Global

B. The fire alarm control panel shall meet UL Standard 864 (Control Units)

C. The system shall be listed by the referenced national agencies as suitable for fire extinguishing releasing applications.

1.05 SUBMITTALS

A. General:
   1. In addition to all submittal requirements as specified by Division 1 as well as all requirements by related specification sections, the fire alarm system submittals shall also be provided in accordance with all requirements of this section for review by the Architect.
      a. In addition to the specific submittal distribution requirements specified above the contractor shall provide an identical submission to authorities having jurisdiction for plan review and permiting. Include copies of annotated Shop Drawings sealed by reregistered engineer, if necessary. Resubmit if required to make requested clarifications or revisions to obtain approval.
         1) The Fire Alarm installation contractor at the time of plan review application and prior to the commencment of any work related with this section shall be responsiblie for submitting all shop drawings for AHJ review in accordance with all requirements. No work shall progress until all shop drawings have been found to be in compliance by the AHJ and design Professional of Record.
            (a) Any fire alarm shop drawings which are submitted for review, shall first be routed through the "Professional of Record" (Architect / Engineer) and shall be stamped with his "Shop Drawing Review Stamp" that shop drawings have been reviewed by him for conformance with all applicable plans, specifications, and appropriate codes.
      b. On receipt of comments from authority and prior to the start of any construction, submit to the Architect for review a copy of all AHJ approved drawings. Failure to comply with this requirement shall extend all liabilities to the contractor for any modifications necessary to the system in order to obtain a Certificate of Occupancy.
   2. Provide a complete set of shop drawings. Drawings shall include sufficient information, clearly presented, to determine full compliance with all project drawings and specifications. Include the following information for review.
      a. All equipment manufacturers' names and model numbers.
      b. All equipment /device electrical ratings and power requirements.
      c. All battery calculations for all control panels, remote panels and auxiliary power supplies integrated with the fire alarm system.
      d. Voltage drop calculations for all initiating, notification and auxiliary circuits.

e. Component layouts, mounting elevations and installation details for all control panels, remote transponder panels and auxiliary power supply panels,
f. Typical device wiring details of all equipment, devices and integrated systems and/or equipment.
g. Complete point-to-point-wiring diagrams for all equipment, devices and integration with all systems and/or equipment associated with the installation, operation and/or connection to the fire alarm system.

3. Wiring diagrams shall indicate wiring for each field device and all interconnections between each device and all controls and/or associated equipment.
4. Provide a complete set of contractor prepared detailed construction drawings. Drawings at the minimum shall consist of building floor plans indicating all fire alarm device locations, device addresses, control panels, auxiliary panels' remote annunciator and/or control panels.
5. Include all equipment data sheets pertinent to all equipment provided. All data sheets shall be highlighted indicating specific equipment supplied

1.06 QUALITY ASSURANCE

A. In addition to all requirements as specified, the fire alarm system shall also be provided in accordance with the following requirements:
   1. The fire alarm equipment provider shall employ technicians on site to provide system certification and programming and testing in accordance with NFPA 72 requirements and shall be dully licensed to provide fire alarm systems within in the municipality of the project and shall be NICET certified (minimum Level II Fire Alarm Technology).

B. Pre-installation Conference: Schedule pre-installation conference at Project site prior to system installation. Review methods and procedures related to the proper installation of the fire alarm system including, but not limited to, the following:
   1. Inspect and discuss electrical and control system roughing-in related to installation of the fire alarm system and the integration with security, HVAC, smoke exhaust and fire suppression systems as well as all preparatory work required to be performed by other trades.
   2. Review all sequence of operations related to the integration of the fire alarm system and building smoke exhaust and security management systems
   3. Review and finalize construction schedule and verify availability of materials, installation personnel, equipment, and any preparatory work by other trades needed to make progress and avoid delays.
   4. Review required start-up, testing, commissioning and certifying procedures to be employed for the fire alarm system and any impacts to other trades.

1.07 SYSTEM DESCRIPTION

A. This Section includes basic design requirements for the installation of a complete Addressable Fire Alarm System as specified herein and as shown on the contract drawings; to be wired, connected, and left in first class operating condition. Include sufficient control panel(s), remote annunciator(s), remote transponder panels, manual stations, automatic fire detectors, smoke detectors, alarm notification appliances, wiring terminations, electrical boxes, and appurtenances as well as all necessary programming, software and labor for a complete operating fire alarm system as herein specified.

B. The fire alarm system shall be an active/interrogative type system where each remote transponder and/or addressable device is repetitively scanned, causing a signal to be transmitted to the main fire alarm control panel (FACP) indicating that all Transponders, field devices and/or all associated circuit wiring is functional. Loss of this signal at the main FACP shall result in a trouble indication as specified hereinafter for the particular input.

C. The fire alarm system shall allow for loading and editing special instructions and operating sequences as required. The system shall be capable of on site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control panel. Loss of primary and secondary power shall not erase the instructions stored in memory. Alarm signals arriving at the main FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

D. Full flexibility for selective input/output control functions based on ANDing, ORing, NOTing, timing, and special coded operations shall also be incorporated in the resident software programming of the system.

E. Resident software shall allow for full configuration of initiating circuits so that additional hardware shall not be necessary to accommodate changes in system function and performance. Resident software shall also allow for configuration of indicating appliance and control circuits so that additional hardware shall not be necessary to accommodate changes.

F. The system shall have the capability of recalling alarms and trouble conditions in chronological order for the purpose of recreating an event in history.

G. Each Initiating Device Circuit (IDC) and/or Signaling Line Circuit (SLC) shall be sized up to 75% of their rated capacity and wired as NFPA 72 Style 4 (Class B) circuits. All Notification Appliance Circuits (NAC) shall be sized up to 75% of their rated capacity and wired as NFPA Style Y (Class B) circuits.

H. The fire alarm system shall provide via dry contact inputs an alarm integration by zone to the security management system programmable logic controllers (PLC) for display on all HMI touch screen terminals any fire alarm condition in accordance with Contract drawings and/or as herein specified
   1. The fire alarm integration shall consist of two fire alarm inputs to the security PLC for the discrete zoned alarm annunciation of general fire alarm indication to be displayed at all security HMI touch screen terminal. The fire alarm shall provide a single alarm indication for both area “A” and area “B” of this facility. Refer to related specification sections for additional information. The contractor shall coordinate all required fire alarm inputs with the ESSI.

1.08 SYSTEM OPERATION

A. The system fire alarm operation subsequent to the alarm activation of any manual station, automatic detection device, or sprinkler flow switch shall be as follows:
   1. Display all alarm location information at the local Fire Alarm Control Panel.
   2. Display all alarm location information on all remote LCD annunciators and network command terminals where provided as part of this project.
   3. Display all alarm location information at the main FACP.
   4. All alarm notification appliances shall sound in a temporal ringing manner, throughout the protected premises, until silenced by the appropriate switch at the fire alarm control panel.
   5. All visual notification appliances, (Strobes) shall operate throughout the protected premises, in a synchronized cadence until the system is reset.
   6. An alarm signal shall be transmitted to main FACP for the facility.
   7. The activation of any alarm-initiating device shall cause the release of all magnetically held open or electronically locked doors.
   8. The alarm activation of any duct-mounted smoke sensor shall initiate all smoke control/exhaust functions in accordance with NFPA 72.
   9. Alarm activation of any automatic smoke detector and/or sprinkler waterflow switch, in addition to above sequence of operations, shall also transmit an automatic signal to the appropriate mechanical equipment to initiate all smoke exhaust functions for the zone of alarm in accordance with all NFPA 92A recommendations and all operations specified

herein.

a. The fire alarm system shall provide all capabilities for manual override, control and status indication of all fans and dampers associated with all smoke control/exhaust functions at the fire fighters control station (FFCS) panel location which shall be provided by the fire alarm system supplier. Refer to division 23 specification sections and Mechanical drawings for coordination of the smoke control/exhaust system configurations and operations.

10. Display all system activities along with time and date of occurrence on all system network command center terminals where provided as part of this project.
11. System activity on the FACP shall retain the information, along with time and date of occurrence in history storage log.
12. Transmit an alarm signal via dry contact to security management system indicating the appropriate zone of alarm.

B. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs shall be activated.

C. The fire alarm system shall monitor the following alarm and supervisory conditions: PUMP RUNNING, PUMP FAIL and PHASE REVERSAL for all electric fire pumps provided as part of this project and/or PUMP RUNNING, PUMP FAIL and Low Fuel for all diesel fire pumps provided as part of this project.

1. The contractor shall coordinate with fire protection contractor for the proper integration of the fire alarm system and fire pump controller in accordance with NFPA 72 and NFPA 20 requirements. Refer to fire protection drawings for exact location and number of fire pump controllers.

D. Where permitted by the authority having jurisdiction the activation of any system smoke sensor shall initiate an Alarm Verification operation, whereby the panel will reset the activated detector and wait for a second alarm activation. If, within one (1) minute after resetting, a second alarm is reported from the same or any other smoke detector, the system shall process the alarm as described previously. If no second alarm occurs within one minute the system shall resume normal operation. The Alarm Verification shall operate only on smoke detector alarms. Other activated initiating devices shall be processed immediately. Device, zone or group of zones shall select the alarm verification operation.

1. The control panel shall have the capability to display the number of times (tally) a zone has gone into a verification mode. Should this smoke verification tally reach a pre-programmed number, a trouble condition shall occur.
2. Alarm verification zones shall be able to be divided into separate groups whereby only verification zones from the same group will confirm the first activation and cause the alarm sequence to occur.

E. The control panel shall have a dedicated supervisory service LED and a dedicated supervisory service acknowledge switch.

F. The activation of any standpipe, PIV valve or sprinkler valve supervisory (tamper) switch shall activate the systems supervisory audible signal and illuminate the LED at the control panel, remote annunciators and printers. Differentiation between valve tamper activation and opens and/or grounds on the initiation circuit wiring shall be provided.

1. Pressing the Supervisory Service Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory Service LED "on" indicating the off-normal condition.
2. Restoring the valve to the normal position shall cause the Supervisory Service LED to extinguish, indicating restoration to normal.
3. All supervisory location information shall be displayed on all remote LCD annunciators and network command terminals where provided as part of this project.

4. A supervisory signal shall be transmitted to the main FACP for the facility.

1.09 SYSTEM SUPERVISION

A. The system shall contain addressable inputs/outputs. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.

B. There shall be a supervisory initiation circuit for connection of all sprinkler supervisory valves (tamper). Device activation shall cause a supervisory alarm condition at the control panel.

C. There shall be the required number of independently supervised and independently fused indicating appliance circuits for audible alarm devices and visual alarm strobes. Disarrangement conditions of any circuit shall not affect the operation of other circuits.

D. Each independently supervised circuit shall include a discrete LCD readout to indicate disarrangement conditions per circuit.

E. The incoming power to the system shall be supervised so that any power failure must be audibly and visually indicated at the control panel. A green "power on" LED shall be displayed continuously while incoming power is present.

F. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control panel.

G. All system modules shall be electrically supervised for module placement. Should a module become disconnected the system trouble indicator shall illuminate and the audible trouble signal shall sound. The system shall have provision for disabling and enabling all circuits, and/or devices individually for maintenance or testing purposes.

H. All trouble indications in addition to above shall display all trouble location information on all remote LCD annunciators and network command terminals where provided as part of this project and a supervisory signal shall be transmitted to an approved central monitoring station.

1.10 SYSTEM POWER REQUIREMENTS

A. All control panels, transponder panels and remote auxiliary power supplies shall receive 120 VAC emergency power via a dedicated fused disconnect circuit from the nearest emergency power distribution panel.

B. All control panels and remote auxiliary power supplies shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120VAC power in a normal supervisory mode for a period of twenty-four (24) hours, with five (5) minutes of alarm activation available at the end of the 24 hour period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operation shall be automatic. Batteries, once discharged, shall recharge at a rate to provide a minimum of 70% capacity in 12 hours.

C. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control panel.

D. All control equipment must have transient protection to comply with UL864 requirements. Where Fire Alarm circuits leave the building, additional transient protection must be provided for each circuit. Devices must be UL listed under standard #497B (Isolated Loop Protectors).

1.11 RECORD DOCUMENTS

A. In addition to all requirements as specified, the fire alarm system shall also be provided in accordance with the following requirements:

1. Provide a complete and current copy of all fire alarm system programming in accordance with all requirements of the paragraph 1.18 of this specification.

1.12 WARRANTY

A. In addition to all requirements as specified by Division 1, the contractor shall also provide the following warranty requirements.
   1. The system is to be fully tested and serviced at the six (6) month interval of the specified warranty period. All smoke detector sensitivities shall be re-checked and compared to detector sensitivities taken at the time of system certification.
      a. If sensitivity tests indicate that the detector has remained within its listed and specified sensitivity range, the length of time between calibration testing shall be extended to a maximum of 5 years.
      b. If the frequency is extended, records of detector-caused nuisance alarms and subsequent trends of these alarms shall be maintained. The contractor shall stipulate in writing or as addenda to the certificate of warranty that full compliance to these requirements will be provided.

1.13 EXTRA MATERIAL

A. In addition to all requirements as specified, the following extra materials shall be provided as part of this project:
   1. Four (4) Addressable Smoke Detectors w/Bases
   2. Four (4) Addressable Heat Detectors w/Bases
   3. Two (2) Addressable Duct Smoke Detectors w/Housings & Sampling Tubes
   4. Three (3) Addressable Monitor Modules
   5. Three (3) Addressable Control Modules
   6. Three (3) ADA Horn/Strobe Units 75 Candela w/Surface Boxes
   7. Three (3) ADA Strobe Units 75 Candela w/Surface Boxes

B. All extra materials shall be delivered at the time of final acceptance of the system(s). At no time is the contractor to use the extra materials provided for this project to replace malfunctioning equipment and or components.

1.14 SOFTWARE AGREEMENT

A. Included as part of the scope of work for this project the Owner shall retain ALL ownership and Access rights to the complete programming for the Fire Alarm system as installed. Any contractor and/or manufacturer that restricts ownership and/or licensing rights of the system programming, installed at the Owner's premises or claims that the system programming is protected by proprietary ownership by the installing contractor, shall be deemed unacceptable for this project.
   1. The contractor shall provide to Owner a complete copy of all fire alarm system programming prior to final acceptance of the system. Programming shall include but not limited to all device identifications, device descriptions, logic matrixes, programing access level passwords as well as all function and sub-function routines.
   2. Programming copies shall be provided to Owner on CD or DVD digitally formatted media in addition, the contractor shall provide a complete hard copy printout of all system programming and point list and shall be included as part of close-out documentation for review by the Architect.
   3. Failure to provide Owner and Architect at the time of project close out, complete copies of all fire alarm system programming shall result in the replacement of the entire fire alarm system at the contractor's expense with a system capable complying with this Software Agreement requirement.

B. Upgrade Software Service: Included in the cost of this project shall be an automatic software upgrade policy, which shall maintain all software to latest version on all new and all existing fire alarm control panels currently installed at the facility for products of the same manufacturer. This upgrade policy shall require the contractor to install and program all software upgrades that become available from manufacturer for a period of one year from date of final acceptance.

1. Upgrading of software shall include all revised/new software, labor, testing recertification as well as all licenses and all programming copies as described in paragraph 1.18, A, of this section for the installation of any new and/or revised software.
2. Provide not less than thirty days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturer's for this project, providing full compliance with this specification section and Division 1 requirements shall be as follows:
   1. Gamewell-FCI; a Honeywell company.
   2. Siemens Building Technologies; Cerberus Division.
   3. EST; a Division of GE Security

B. Manufacturers listed as acceptable shall not negate the contractor's responsibility for providing the fire alarm system in accordance with all functions and performance requirements of this specification.

C. Where manufacturer and/or model numbers reference specific system components in this specification, it is to establish the performance requirements and quality of the systems and components only.
   1. It is in no way an inference that the referenced model numbers are the manufacturer's current product and are the only acceptable components for this project unless specifically referenced as "no substitutions".
   2. Contractor shall provide the manufacturers' most current product that shall meet and/or exceed the specified performance and features of all fire alarm equipment and/or systems.
   3. Equivalent UL-listed equipment may be substituted for the approved manufacturers in accordance with all requirements of Division 1 specification section titled "Substitutions" and/or General Conditions to the Construction Contract.
      a. All substitutions shall comply with all requirements as specified in related specification sections and all system performance standards shall be maintained. Where systems and/or components are referenced as "no substitutions" the specific system and/or components shall be provided.
      b. In addition to all requirements of Division 1 for substitutions the contractor shall also provide the following information for any proposed product or equipment substitutions.
         1) Any and all extensions in time impacted by the substitution.
         2) Any changes to the architectural or structural elements to the project.
         3) Differences in operation and/or performance from intended system criteria.
      c. Failure to provide the required substitution information shall result in "without consideration" the immediate rejection of the substituted equipment and/or systems.

D. Each and all items of the Fire Alarm System shall be listed as a product of a SINGLE fire alarm system manufacturer under the appropriate category by Underwriter's Laboratories, Inc. (UL), and shall bear the "U.L." label. All control equipment shall be listed under UL category UOJZ as a single control unit. Partial listing shall NOT be acceptable.

E. The fire alarm equipment manufacturer shall be an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.

2.02 FIRE ALARM CONTROL PANEL

A. Control Panel construction shall be modular with solid state, microprocessor based electronics. It shall display only that primary controls and displays essential to operation during a fire alarm condition. Keyboards or keypads shall not be required to operate the fire alarm control during a fire alarm condition.

B. At a minimum the following primary controls shall be visible through a front access panel:
   1. Eighty-character liquid crystal display.
   2. Individual red system alarm LED.
   3. Individual yellow supervisory service LED.
   4. Individual yellow trouble LED.
   5. Green "power on" LED.
   6. Alarm Acknowledge Key.
   7. Supervisory Acknowledge Key.
   8. Trouble Acknowledge Key.
   9. Alarm Silence Key.
   10. System Reset Key.

C. The following secondary control switches shall be available behind the access panel:
   1. City Box disconnect/switch (Central Station Connection)
   2. Manual evacuation (drill)
   3. Elevator Shunt Trip bypass
   4. Spare

D. At a minimum the control panel shall provide the following:
   1. Setting of time and date.
   2. Lamp Test.
   3. Alarm, trouble, and abnormal condition listings.
   4. Enabling and disabling of each monitor point separately.
   5. Activation and deactivation of each control point separately.
   6. Multiple operator access levels.
   7. Walk Test enable/disable.
   8. Running diagnostic functions.
   9. Displaying software revision level.
   10. Displaying historical logs.
   11. Displaying card status.
   12. Point listing.

E. For maintenance purposes the following lists shall be available from the point lists menu:
   1. All points list by address.
   2. Monitor point list.
   3. Auxiliary control list.
   4. Scrolling through menu options or lists shall be accomplished in a self-directing manner. These controls shall be located behind an access panel.

F. Primary Keys, LED's and LCD Display:
   1. The control panel shall have at the minimum a 2 line x 80-character liquid crystal display, which shall be backlit for enhanced readability. So as to conserve battery standby power, it shall not be lit during an AC power failure unless an alarm condition occurs or there is keypad activity.
   2. The display shall support both upper and lower case letters. Lowercase letters shall be used for soft key titles and prompting the user. Uppercase letters shall be used for system status information. A cursor shall be visible when entering information.

G. The control panel shall automatically perform a daily self-test on each sensor. Checking the electronics in the sensor's base ensures the accuracy of the values being transmitted to the control panel. A sensor which fails the self-test will cause a "Self Test Abnormal" trouble condition at the control panel. Systems requiring a manually initiated self-test by an operator shall not be acceptable.

H. An operator at the control panel, having a proper access level, shall have the capability to manually access the following information for each sensor:
   1. primary status
   2. device type
   3. present average value
   4. present sensitivity selected
   5. peak detection values
   6. sensor range (normal, dirty, etc.)

I. If the proposed system does not have the capabilities defined in paragraphs 2.2A through 2.2H, a maintenance and testing service program providing the following shall be included with the base bid:
   1. Bi-annual sensitivity reading and logging for each sense. This is to be accomplished by use of a UL listed sensitivity calibration device per the requirement of NFPA-72.
   2. Schedule bi-annual threshold adjustments to maintain proper sensitivity for each smoke detector.
   3. Threshold adjustments to any smoke detector that has alarmed the system without the presence of particles of combustion. This service shall be performed within 4 hours of any such occurrence.
   4. Schedule bi-annual cleaning or replacement of each smoke detector or sensor within the system.
   5. If any device alarms the system without the presence of particles of combustion twice within 30 days, it shall be cleaned or replaced.
   6. Semi-annual functional testing of each detector using the manufacturers calibrated test tool (Unmeasured smoke or aerosol injection shall not be permitted).
   7. Written documentation of all testing, cleaning, replacing, threshold adjustment, and sensitivity reading for each automatic smoke-sensing device within the system.
   8. The initial service included in the bid price shall provide the above listed procedures for a period of five years after Owner acceptance of system.

J. An operator at the control panel, having a proper access level, shall have the capability to manually control the following for each sensor:
   1. Clear peak detection values
   2. Enable or disable the point
   3. Clear verification tally
   4. Control a sensor's relay driver output

K. It shall be possible to program the control panel to automatically change the sensitivity settings of each sensor based on time-of-day and day-of-week. (For example, to be more sensitive during unoccupied times and less sensitive during occupied periods.) There shall be seven sensitivity settings available for each sensor.

L. Under normal condition the front panel shall display a "System is Normal" message and the current time and date.

M. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory, or Trouble) shall flash. The panel audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

N. The LCD shall display the following information relative to the abnormal condition of a point in the system:
   1. 80-character custom location label.
   2. Type of device (i.e. smoke, pull station, water flow).
   3. Point status (i.e. alarm, trouble).

O. Acknowledgment for each abnormal condition shall be (PER NFPA 72 Requirements).

1. Pressing the appropriate acknowledge button shall display the first unacknowledged condition in the appropriate list (either alarm, supervisory, or trouble), and require another acknowledge button. Press to acknowledge only the displayed point.
2. After all points have been acknowledged, the LCD's shall glow steady and the Sonalert will be silenced. The total number of alarms, supervisory and trouble conditions shall be displayed along with a prompt to review each list chronologically. An end of list message “END of LIST” shall indicate the end of the list.

P. Alarm Silencing
1. Should the "Alarm Silence" button be pressed all audible alarm signals shall cease operation.

Q. System Reset
1. The SYSTEM RESET button shall be used to return the system to its normal state after an alarm condition has been remedied. The LCD display shall step the user through the reset process with simple English Language messages. Messages, "SYSTEM RESET IN PROGRESS" will first be displayed followed by the message, "SYSTEM RESET COMPLETED", and finally, "SYSTEM IS NORMAL", should all alarm conditions be cleared.
2. Should the alarm condition continue the message, "SYSTEM RESET IN PROGRESS", will be followed by the message, "SYSTEM RESET ABORTED", and the system will remain in an abnormal state. System control relays shall not reset. The Sonalert and the Alarm LED will be on. The display will indicate the total number of alarms and troubles present in the system along with a prompt to use the ACK keys to review the points. These points will not require acknowledgment if they were previously acknowledged.

R. Function Keys:
1. Additional function keys shall be provided to access status data for the following points:
    a. Initiating device circuits.
    b. Indicating appliance circuits.
    c. Auxiliary Relays.
    d. All other input/output points.
2. The following data shall be available:
    a. Primary State of point
    b. Zone, PID, and Card type information
    c. Current priority of outputs
    d. Disable/enable status
    e. Verification tallies of initiating devices
    f. Automatic/Manual Control Status of output points
    g. Acknowledge status

S. History Logging:
1. The system shall be capable of logging and storing 300 events in an alarm log and 300 events in trouble log. These events shall be stored in a battery protected random access memory. Each recorded event shall include the time and date of that event's occurrence.
2. The following Historical Alarm Log events shall be stored:
    a. Alarms
    b. Alarm Acknowledgment
    c. Alarm Silence
    d. System Reset
    e. Alarm Historical log cleared
3. The following Historical Trouble Log events shall be stored:
    a. Trouble conditions
    b. Supervisory Alarms

c. Trouble Acknowledgment
d. Supervisory Acknowledgment

4. Alarm Verification tallies
   a. Walk Test Results
   b. Trouble Historical log cleared

T. LED Supervision:
1. All slave module LED's shall be supervised for burnout or disarrangement. Should a problem occur the LCD shall display the module and LED location numbers to facilitate location of that LED.

U. System Trouble Reminder:
1. Should a trouble condition be present within the system and the audible trouble signal silenced, the trouble signal shall resound at preprogrammed time intervals to act as reminder that the fire alarm system is not 100% operational. Both the time interval and the trouble reminder signal shall be programmable to suit the Owner's application.

V. Access Levels:
1. There shall be a minimum of four (4) access levels with level 4 being the highest level. Level 1 action shall not require a pass code. Pass codes shall consist of up to ten (10) digits. Changes to pass codes shall only be made by authorized personnel.
2. In order to maintain security when entering a pass code the digits entered will not be displayed but a cursor will move along filling the position with an x to indicate that the digit has been accepted. All key presses will be acknowledged by a local audible sound.
3. When a correct pass code is entered, the message "Access Granted" shall be displayed. The new access level shall be in effect until the operator manually logs out or the keypads have been inactive for (10) minutes.
4. Should an invalid code be input, the operator shall be notified with the message, "ERROR...INCORRECT PASS CODE", and shall be allowed up to three chances to enter a valid code. After three unsuccessful tries, the message, "ACCESS DENIED", shall be displayed. The level shall not be altered, and the operator shall no longer be in the menu option.
5. Access to a level will only allow the operator to perform all actions within that level plus all actions of lower levels, not higher levels.
6. The following keys/switches shall have access levels associated with them:
   a. Alarm Silence
   b. System Reset
   c. Set Time/Date
   d. Manual Control
   e. On/Off/Auto Control
   f. Disable/Enable
   g. Clear Historical Alarm Log
   h. Clear Historical Trouble Log
   i. Walk Test
   j. Change Alarm Verification
7. Acknowledge keys shall also require privileged access to acknowledge points. If the operator presses an (ACK) key with insufficient access, an error message will be displayed. The points will scroll with (ACK) key presses to view the points on the list, but the points will not get acknowledged in the database.

2.03 ADDRESSABLE PERIPHERAL NETWORK

A. Communication with addressable devices:
1. The system must provide communication with initiating and control devices individually. All of these devices will be individually annunciated at the control panel. Annunciation

shall include the following conditions for each point:
   a. Alarm
   b. Trouble
   c. Open
   d. Short
   e. Device missing/failed
   f. Device Type

B. All addressable devices shall have the capability of being disabled or enabled individually from the main fire alarm control panel and all remote annunciator panels.

C. Up to a maximum of 127 addressable devices may be multi-dropped from a single Initiating Device Circuit. Systems that do not support field reprogramming to add or delete devices are unacceptable.

D. Format:
   1. The communication format must be a completely digital poll/response protocol to allow t-tapping of the circuit wiring. A high degree of communication reliability must be obtained by using parity data bit error checking routines for address coded and check sum routines for the data transmission portion of the protocol. Systems that do not utilize full digital transmission protocol are not acceptable.

E. Identification of Addressable Devices:
   1. Each addressable device must be uniquely identified by an address code entered on each device at time of installation. Systems requiring special device programming instruments are acceptable providing a spare programming instrument is provided to the Owner at no additional cost. The use of jumpers to set address will not be acceptable due to the potential of vibration and poor contact. Device identification schemes that do not use uniquely set addresses but rely on electrical position along the communication channel are unacceptable. The system must verify that the proper type device is in place and matches the desired software configuration.

F. Wiring Type, Distances, Survivability, and Configurations:
   1. Wiring types will be approved by the equipment manufacturer. Existing wiring may be utilized in retrofit applications. The system shall allow at a minimum a line distance of up to 2,500 feet to the furthest addressable device on a Class B circuit. To minimize wire routing and to facilitate future additions t-tapping of the communications channel will be supported.

G. Alphanumeric Remote Annunciator Panel (FAAP):
   1. Provide Remote Fire Alarm Annunciator Panel(s) where indicated on drawings and/or as required by the authority having jurisdiction.
      a. At the minimum the contractor shall provide fire alarm annunciator panels at the main building entrance and main office unless otherwise indicated by the contract drawings.
   2. The remote fire alarm annunciator panel shall be a supervised, backlit LCD alphanumeric display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
   3. The remote annunciator shall display all alarm and trouble conditions from either the network node or the complete network.
   4. A minimum of 10 remote annunciator panels may be connected to a specific (terminal mode) EIA 485 interface. To total number remote annunciator panels shall not reduce the annunciation capacity of the system. Each LCD shall include vital system wide functions such as, system acknowledge, silence and reset.
   5. LCD display annunciator shall mimic the local control panel 80-character display or network annunciator and shall not require special programming.

6. All LCD annunciators installed shall be provided with locking door or keyed enable switch. All LCD annunciators installed, as surface mounted devices shall also be mounted on a color-coordinated manufacturer's listed surface back-box.

H. Fire Fighter Control Station (FFCS):
1. The Fire Fighters Control Station shall be located as indicated on the contract drawings and shall contain all equipment required for all manual smoke control/exhaust functions. The FFCS shall include all manual controls, and operation indication for the smoke evacuaction system. The FFCS at the minimum shall perform the following functions:
2. Provide manual control and status indication of all fans and dampers associated with the engineered smoke control/exhaust systems for all areas as indicated on the Division 23 mechanical drawings, Divison 28 fire alarm drawings and/or as herein specified. Refer to all related documents for additional information.
3. The FFCS shall be provided by the fire alarm equipment provider and shall be modular in construction. The FFCS shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment. All FFCS components shall be protected against unusually high voltage surges or line transients.
4. The FFCS shall be an integral component of the fire alarm control panel's communications network and shall provide all manual control and status indication on the annunciator panel and shall be equipped with all necessary switches and status indicators in sufficient capacity to provide the capability to control and display the status of all AHU fans and/or dampers which make up a part of the engineered smoke control/exhaust system.
5. The FFCS shall comply with UL smoke control/exhaust requirements for dedicated and non-dedicated systems as well as NFPA 90A, 92A, and 92B standards for smoke control/exhaust. The FFCS shall also comply with UL 916 Energy Management, UL 916 Signal System Units and UL 864 Process Management.
6. The FFCS shall provide as part of its mode of operation the capability to operate as the manual interface for all operations of the engineered smoke control/exhaust system. Each switch and status indicator lamp shall be assigned a dedicated fan and/or damper and shall be configured to provide the following operational functions.
    a. Fan Control - 3-position ON/AUTO/OFF latching switch
    b. Fan Operation - ON indicator lamp (Green)
    c. Fan Operation - OFF indicator lamp (RED)
    d. Damper Control - 3-position OPEN/AUTO/CLOSED latching switch
    e. Damper Operation - OPEN indicator lamp (Green)
    f. Damper Operation - CLOSED indicator lamp (RED)
    g. One - Trouble indicator lamp (Amber).
7. Each "ON/AUTO/OFF" or OPEN/AUTO/CLOSED switch position on the FFCS is responsible for controlling a single dedicated fan and/or damper associated with the engineered smoke control/exhaust system as well as bypassing all automatic functions of the Building Automation System associated with a specific fan and/or damper. Each switch function shall be mapped to a specific addressable control module in order to provide the capability of manual control of the related functions. (I.e. Fan-On, Fan-Off Damper-Open, Damper Closed). The "Auto" switch position shall act as a neutral function allowing the dedicated addressable control module associated with the interface to the Building Automation System to provide automatic activation the smoke control/exhaust system for the facility. Refer to Division 23 contract drawings for the exact location and quantity of all fans and dampers related to the engineered smoke control/exhaust system.
8. Each status indicator on the FFCS shall be responsible for providing a positive indication of its related function (I.e. Fan-On, Fan-Off, Damper-Open, Damper-Closed). Each status indication shall be mapped to a specific addressable monitor module interfaced to the appropriate fan sail switch and/or damper end switch in order to provide positive indication

of the condition for each supply and/or exhaust fan as well as the open and closed status for each damper associated with the engineered smoke control/exhaust system for the facility.

9. In addition to the above the configuration FFCS panel shall include at the minimum the following
    a. A framed graphic floor plan of the housing unit indicating all floors, smoke control zones, rooms, corridors, exits and all fan and damper locations associated within the protected areas shall be provided and located adjacent to all FFCS panels.

I. Transponders: (Remote Data Gathering Panels – DGP):
1. The contractor shall provide all remote fire alarm transponders panels where indicated by the contract drawings or as required by the manufacturer in order to meet all system performance requirements as herein specified.
2. All Transponders shall be listed under UL category UOJZ as an independent, local fire alarm control unit as well as being listed as a critical component in a multiplex fire alarm system. All Transponders panels shall be capable of being incorporated to the existing fire alarm control panel without the need of any additional modules and or control panel modifications. The Transponder shall serve as the interface between addressable initiating fire alarm devices, conventional initiating fire devices, controlled notification appliances and the FACP. The supervised multiplex communication port shall be an integral part of the transponder.
3. Each Transponder shall be powered from a local Power Supply, and shall provide all power necessary for its own operation, including standby power in accordance with project specifications.
4. Transponders shall be capable of housing all batteries, power supplies and/or amplifiers to allow a true distributed processing and amplification.
5. Each transponder shall have the following indicators and operator controls:
    a. Alarm Acknowledge/Signal Silence/Reset Switch
    b. Power LED
    c. System alarm LED
    d. System trouble LED
    e. Local piezoelectric signal
    f. Red alarm per Initiating Device Circuit
    g. Green on/off LED per notification appliance circuit or relay
6. Each transponder will be capable of expansion of up to 24 field circuits of the following types in any mix:
    a. Addressable Initiating Device Circuits (IDC): Up to 24.IDC’s may be added to the transponder
    b. Initiating Device Circuits (IDC): IDCs may be added to the transponder in groups of 8 Style B (Class B), or 4 Style D (Class A) circuits. Each circuit shall be capable of monitoring up to 30 compatible 2-wire smoke detectors, and/or any number of contact type initiating devices.
    c. Auxiliary Control Relay Outputs: Auxiliary relay outputs may be added to the transponder in groups of eight individually controlled single Form-C circuits. Alternately, the eight independent relays may be configured as four dual Form-C. All relay contacts shall be rated 2 A @ 30 VDC. Notification Appliance Circuits: Notification Appliance Circuit outputs may be added to the transponder in groups of 8 Class B (Style Y), or 4 Class A (Style Z) circuits. Each circuit shall be capable of being configured as a Telephone, Horn, Strobe or Speaker Circuit.

J. Field Charging Power Supply: (FCPS):
1. The FCPS shall be designed for use as an auxiliary power supply listed for use as a remote 24-volt power supply and/or as a remote Notification Appliance power supply. The

contractor shall provide all FCPS panels where indicated by the contract drawings or as required in order to meet all system performance requirements as herein specified.

a. The FCPS shall offer up to 6.0 amps (4.0 amps continuous) of regulated 24 volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 24 hour standby with five minutes of alarm.
b. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.
c. The Field Charging Power Supply shall include the ability to delay the AC fail delay per 1993 NFPA requirements.
d. The FCPS include power limited circuitry, per 1995 UL standards.

2.04 PERIPHERAL DEVICES

A. Addressable Device Types:
1. General:
a. The system control panel must be capable of communicating with the types of addressable devices specified below. Addressable devices will be located as shown on the drawings. The system shall have "individual" device addressability. Each system device shall have its own address.
b. All smoke/heat sensors shall be listed to UL Standard 268 and shall be documented compatible with the control equipment to which they are connected. The sensors shall be listed for both ceiling and wall mount applications.
c. Each smoke/heat sensor base shall contain an LED that will flash each time it is scanned by the control panel (once every 4 seconds). When the control panel determines that a sensor is in an alarm or a trouble condition, the control panel shall command the LED on that sensor's base to turn on steady indicating the abnormal condition. Sensors, which do not provide a visible indication of an abnormal condition, shall not be acceptable.
d. All smoke/heat sensor bases, where shown on the plans as required, shall be provided with a relay driver and/or local sounder base output that is to be controlled either automatically or manually from the control panel.
e. Each smoke/heat Sensor shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
f. All sensors shall be scanned by the control panel for its type identification to prevent inadvertent substitution of another sensor type. The control panel shall operate with the installed device but shall initiate a "Wrong Device" trouble condition until the proper type is installed or the programmed sensor type is changed.
g. All sensors' electronics shall be immune from false alarm caused by EMI and RF.

B. Addressable Pull Box (manual station):
1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset. Stations that utilize a special wrench or Allen key shall not be accepted.
3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger. Manual stations where indicated on the contract drawings, as institutional type stations shall be UL listed for that type of application.

4. Furnish and install clear Lexan protective covers w/self contained horn on all manual pull stations where indicated on contract drawings as “protected with wire guards”. All protective covers shall be UL listed for the application.
5. All manual pull stations installed, as surface mounted devices shall be mounted on a color-coordinated manufacturer’s listed surface back-box. All manual pull stations installed in locations exposed to the weather or installed in wet/damp locations shall be listed for that application and mounted on manufacturer’s back-box listed for weatherproof applications.

C. Intelligent Photoelectric Smoke Detector:
1. The intelligent smoke detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
2. Furnish and install wire guards on all smoke detectors, where indicated on contract drawings. All wire guards shall be UL listed for the application.

D. Intelligent Duct Smoke Detectors:
1. The intelligent duct smoke detectors shall be photoelectric and listed by Underwriters’ Laboratories, Inc. Each smoke sensor and air duct housing shall be self-compensating for the effects of air velocity (from 300 to 4,000 FM), temperature, humidity and atmospheric pressure. It shall not be necessary to field adjust the sensitivity to compensate for the above effects. Each smoke sensor shall utilize solid state components and be equipped with an integral alarm indicating LED, which shall flash when the smoke sensor is activated. In addition each duct smoke detector shall be equipped with a programmable form “C” remote relay with contacts rated at 3 AMPS, 120 VAC resistive or 24 VDC resistive and wired for fan shut down requirements and or other related smoke control functions as required by code.
2. Duct smoke detectors shall be capable of a programming format that permits a supervisory signal to be transmitted to the fire alarm control panel while providing a latched relay state on the fan control interface until reset of the fire alarm control panel.
3. Each duct-smoke detector shall be provided with a remote test station and remote alarm-indicating lamp in accordance with all requirements of NFPA 72. All remote test stations shall be key operated and shall be installed at 5 feet above finished floor. Remote indicating lamps can be integral to the remote test or can be stand-alone devices. Remote indicating lamps that are stand-alone devices shall be listed for use with the duct smoke detector and can be mounted on wall or ceilings.
4. Duct-smoke detectors shall be provided and wired by the Division 26 contractor and installed by the Division 23 contractor. Refer to Division 23 documents for additional information regarding location and quantities of detectors.

E. Weather Proof Duct Smoke Detectors:
1. The weather proof duct smoke detectors shall be photoelectric and listed by Underwriters’ Laboratories, Inc for exterior environments from 32 F to 155 F at a relative humidity of 10% to 85% condensation. Each smoke sensor shall be self-compensating for the effects of air velocity (from 100 to 4,000 FM). Each smoke sensor shall utilize solid state components and be equipped with an integral alarm indicating LED, which shall flash when the smoke sensor is activated. In addition each duct smoke detector shall be equipped 2 sets of form C Alarm contacts rated at 10A and 1 set of form C Trouble contacts rated at 10A. The duct smoke detector shall be wired to an addressable monitor module which shall provide all alarm and trouble indications to the main fire alarm control panel. All fan shut functions shall be accomplished by the installation of a dedicated addressable control module .Smoke detector shall be model SSU-SL02000-P or approved equal.
2. Duct smoke detector housing shall be a NEMA 3R weather proof enclosure UL listed for that application. The duct-smoke detector housing shall be provided integral heater listed

for use with duct detector housing and required air sampling tubes sized for the application. The integral heater kit shall be module OP-001 as manufactured by Space Age Electronics. The weather proof duct detector housing shall be model SSU-WP-2000 as manufactured by Space Age Electronics or approved equal

3. Duct-smoke detectors shall be provided and wired by the Division 26 contractor and installed by the Division 23 contractor. Refer to ES series drawings and Division 23 documents for additional information regarding location and quantities of detectors.

F. Intelligent Thermal Detectors:
   1. Thermal detectors where indicated on the drawings shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.
   2. Furnish and install wire guards on all heat detectors, where indicated on contract drawings. All wire guards shall be UL listed for the application.

G. Conventional Thermal Detectors:
   1. Thermal detectors were indicated as conventional detectors on the drawings shall be rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F per minute. It shall connect via an addressable zone module to the fire alarm control panel signaling line circuit. Maximum number of devices permitted any single IDC circuit shall be 15 devices per addressable zone module and shall be provided in only areas indicated by the contract documents or identified as zoned conventional devices on the fire alarm riser diagram.
   2. Thermal detectors were indicated as conventional detectors fixed temperature on the drawings shall be rated at 135 degrees Fahrenheit. It shall connect via an addressable zone module to the fire alarm control panel signaling line circuit. Maximum number of devices permitted on any single IDC circuit shall be 15 devices per addressable zone module and shall be provided in only areas indicated by the contract documents or identified as zoned conventional devices on the fire alarm riser diagram.
   3. Thermal detectors were indicated as conventional detectors fixed temperature on the drawings shall be rated at 190 degrees Fahrenheit. It shall connect via an addressable zone module to the fire alarm control panel signaling line circuit. Maximum number of devices permitted on any single IDC circuit shall be 15 devices per addressable zone module and shall be provided in only areas indicated by the contract documents or identified as zoned conventional devices on the fire alarm riser diagram.

H. Addressable Dry Contact Monitor Module:
   1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices such as sprinkler water flow switches, pressure switches, sprinkler control valves and conventional heat detectors and/or any N.O. dry contact device to fire alarm system SLCs.
   2. The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.
   3. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
   4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.

I. Two Wire Detector Monitor Module:
   1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).

2. The two-wire monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box or with an optional surface back-box.
3. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

J. Addressable Control Module:
1. Addressable control modules shall be provided to supervise and control the operation of conventional NACs of compatible, 24 VDC polarized audio/visual notification appliances and/or fan shutdown and other auxiliary control functions, in which case the control module shall be configured to operate as a dry contract relay.
2. The control module shall mount in a standard 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box, or to a surface mounted back-box.
3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
    a. A separate supervised power circuit from the main fire alarm control panel or from a supervised shall provide Audio/visual power, UL listed remote power supply.
    b. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

K. Digital Alarm Communicator (DACT):
1. A digital alarm communicator shall be provided as part of this project. Provide coordination with Owner for the preferred alarm monitoring service and all required phone lines.
    a. The digital communicator (DACT) shall be UL listed for remote station reporting in accordance with NFPA 72, UL 864, and UL 1635. The DACT shall be capable of reporting general alarm, general supervisory, general trouble as well as all system status information such as loss of AC, low battery, ground fault and loss of supervision, each with individual and distinct messages to a central or remote monitoring station for each of the above conditions.
    b. The communicator shall have a dual phone line capability and configured with line seizure in accordance with NFPA 72 requirements. The communicator must be capable of reporting in the following communications formats: SIA, 3+1 Standard, 4+1 Standard and 4+2 Standard. The capability of Contact ID format shall be provided where required by the authority having jurisdiction. The communicator shall have a delayed AC loss report function, which will provide a programmable report delay plus a 10-25 min random component to help ease traffic to the central station during a power outage. Controls that use External modems for remote programming and diagnostics shall not be accepted.
    c. Secondary power supply (battery backup) for the DACT shall have sufficient capacity to power the unit its entirety for not less than 60 hours plus 15 minutes of continuous operation upon any loss of normal AC power.

L. Batteries:
1. The batteries shall be sealed Gel Cell type, 12-volt nominal.
2. The battery shall have sufficient capacity to power the complete fire alarm system and all ancillary control units in their entirety for not less than 60 hours plus 5 minutes of continuous operation of all system notification appliances upon any loss of normal AC power.

M. Combination Horn/Strobe Assembly:
1. Furnish and install where indicated on drawings combination “synchronized” horn/strobe audio/visual notification appliances. Horn unit shall produce a minimum sound pressure

level of 88db at 10 feet and shall be UL listed for fire alarm use. The strobe lens shall be clear and the housing engraved, “FIRE”. The contractor shall be responsible for providing the required candela rating for each strobe light based on the device location in accordance with all requirements of NFPA 72 and UL 1971.

2. Furnish and install wire guards on all Horn/Strobe units, where indicated on contract drawings. All wire guards shall be UL listed for the application.
3. All horn/strobe devices installed, as surface mounted devices shall be mounted on a color-coordinated manufacturer’s listed surface backbox. All horn/strobe devices installed in locations exposed to the weather or installed in wet/damp locations shall be listed for that application and mounted on manufacturer’s backbox listed for weather proof applications.

N. Horn Unit Assembly:
1. Furnish and install where indicated on drawings horn notification appliances. The horn unit shall produce a minimum sound pressure level of 88db at 10 feet and shall be UL listed for fire alarm use.
2. Furnish and install wire guards on all Horn units, where indicated on contract drawings.
3. All horn devices installed, as surface mounted devices shall be mounted on a color-coordinated manufacturer’s listed surface backbox. All horn devices installed in locations exposed to the weather or installed in wet/damp locations shall be listed for that application and mounted on manufacturer’s backbox listed for weather proof applications.

O. Bell Unit:
1. Furnish and install where indicated on drawings 10” vibrating Bell notification appliance. The Bell units shall produce a minimum sound pressure level of 88db at 10 feet and shall be UL listed for fire alarm use.
2. Furnish and install wire guards on all Bell units, where indicated on contract drawings.
3. All Bells installed, as surface mounted devices shall be mounted on a color-coordinated manufacturer’s listed surface backbox. All Bell Units installed in locations exposed to the weather or installed in wet/damp locations shall be listed for that application and mounted on manufacturer’s backbox listed for weather proof applications.

P. Visual Flashing Strobe:
1. Furnish and install where indicated on drawings “synchronized” strobe notification appliances. The strobe lens shall be clear and the housing engraved, “FIRE”. The contractor shall be responsible for providing the required candela rating for each strobe light based on the device location in accordance with all requirements of NFPA 72 and UL 1971.
2. Furnish and install wire guards on all Strobe units, where indicated on contract drawings.
3. All strobe devices installed, as surface mounted devices shall be mounted on a color-coordinated manufacturer’s listed surface back-box. All strobe devices installed in locations exposed to the weather or installed in wet/damp locations shall be listed for that application and mounted on manufacturer’s back-box listed for weatherproof applications.

2.05 SECURITY SYSTEM INTERFACE

A. Provide interface to security system in accordance with Division 28 and Contract Documents.

PART 3 – EXECUTION

3.01 INSTALLATION

A. In addition to all requirements as specified the fire alarm system shall also be provided in accordance with the following requirements:
1. All fire alarm system wiring shall be installed in strict compliance with all the provisions of NEC-Article 760 A and C, Power-Limited Fire Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with NEC-Article 760. Upon completion, the contractor shall so certify in writing to the Architect of such compliance.

2. All fire alarm system wiring shall be installed in dedicated conduits or raceways.
3. Installation of all equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate trade contractors. Coordinate with Architect for connection and location to the building's PSTN circuits and location of RJ31-X phone jacks for the proper connection and programming to Owner's alarm monitoring service.

B. The contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.

3.02 FIELD SERVICES

A. Testing:
1. In addition to all requirements as specified in Division 1, the fire alarm system shall also comply with the following requirements:
   a. The completed fire alarm system shall be fully tested in accordance with all NFPA 72 testing and certification requirements. Upon completion of a successful testing, the contractor shall so certify in writing to the Owner and Architect all testing was completed, certified and left in first class operational condition, the contractor shall submit to the Architect for review all completed NFPA 72 certification, calibration and test reports prior to final acceptance..
   b. In addition the contractor shall provide to the Owner and Architect written documentation of all testing, cleaning, threshold settings, and sensitivity readings for each automatic smoke-sensing device within the system.
   c. The service of a competent, factory-trained engineer or NICET Level III technician authorized by the equipment manufacturer and licensed by the state shall be provided to technically supervise installation and participate during initial system start-up, final testing and assist the Authority Having Jurisdiction during final acceptance testing.
   d. At the final inspection, a factory-trained representative of the equipment manufacturer shall demonstrate to the Owner and Architect that the system functions properly in every respect and is in full compliance with the contract documents. .
   e. Provide a minimum of two 4-hour training classes at the project location. Include training manuals, video instructions and hands-on demonstrations in the operation of all system components. Resubmit to the Owner and Architect in advance all lesson plans outlying training procedures, course outlines and objectives. Coordinate with Owner in advance of all training dates and schedules.
   f. The contractor shall provide a typewritten framed "Sequence of Operation." Posted at the main fire alarm control panel and at all remote annunciator panel locations.
   g. Provide written notification to the Owner and Architect of the systems condition before and after service, exact components that were tested, detector sensitivity readings, battery conditions and overall status of the system.
2. Inspections:
   a. At the completion of the project and prior to final acceptance of the Work, provide evidence to the Architect and Owner of all final tests, inspections, certifications and approvals of the Authorities Having Jurisdiction (where required by the governing municipality).

END OF SECTION

SECTION 28 4000
CONTROL SYSTEMS FOR SECURITY

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

B. Refer to all Contract Drawings and specification sections listed in Section 28 0500 and 28 0510 for additional requirements.

C. Refer to Section 28 0530 for Operational Sequences.

D. Refer to Division 26 and 27 and the Electrical drawings for coordination requirements for power and infrastructure.

1.02 SYSTEM DESCRIPTION

A. The system shall control, annunciate and monitor all Security and Communication special system points via the Central Control Centers operator stations and Local Control Stations as shown on the Contact Drawings, indicated in the specifications and support the functions as described herein and in the Security and Communication Systems.

B. The Control System shall consist of a multi-tier design of networked PLCs; two for Central Control with dual processors and redundant power supplies, and one for each local control, Touchscreen Computers (TSC) workstations with Graphical User Interfaces (GUI). There will be two (2) operator TSC workstations at Central Control; and one TSC workstation at each Local Control Station for each Housing Unit, Medical, and Booking. All remote PLCs and TSC will be networked through a fiber optic Ethernet network. The Control System shall be interfaced to the Video Surveillance System and Intercom/Paging System and other systems shown or described for a fully integrated Control System.

C. Provide a new RAID 5 type server grade computers at the Security Equipment Room, with Central Processing Units (CPU and Central PLC). Refer to all specifications for additional requirements. Provide all devices necessary including hard disks, removable backup disk driver, printer, necessary power supplies and batteries, remote terminal units, interfaces, software, and miscellaneous wire, connectors, to meet all the functions and features as described in these specifications and as shown on the Contract Drawings.

D. Provide server-grade workstation computers for Central Control and Local Control workstations. Each workstation computer shall include a minimum 27” LCD touch-screen monitor, wireless optical mouse and keyboard.

E. Provide Programmable Logic Control (PLC) system including all remote PLCs or Remote Input Output Units networked to the master PLC for control and monitoring of selected doors, intercom control and integration, integration of Video Surveillance System and duress alarms via the Central Control Center.
   1. Provide Central Processing Unit (CPU), power supplies and batteries, input and output modules, specialty interfaces, communication modules, software, and miscellaneous wire, connectors, to meet all the functions and features as described in these specifications and as shown on the Contract Drawings.

F. The PLC shall contain supervised type communication circuits as required to control and monitor any/all special system devices located throughout the Project Site.

G. Contractor shall be responsible for any and all necessary data switches and fiber optic cabling connecting and integrating the systems together as described within the Contract Documents.

H. Provide all Network Interface Processor (NIP) and Remote Access network interface, switches, modem, patch panels and miscellaneous in the Security Equipment room.

I. Provide remote diagnostic link hardware and software to allow remote diagnostic monitoring and correction of security control system include the PLC, Graphical User Interface computer systems and the SCADA system. The telephone link shall be through a contractor supplied A-B switch.

J. Provide all control networking hardware and software including all Ethernet interfaces, switches, hubs, UTP, fiber optic cables, and miscellaneous distribution hardware for all control work and integration of controls.

K. Provide an interface, either serial or Ethernet, between Fire Alarm Control Panel and CCC Security Computer system to provide redundant fire alarm notification on the CCC GUI screen.

L. Provide all necessary software including operating system hardware, application, PLC and supervisory (SCADA) software.

1.03 SECURITY & COMMUNICATION(SC) - SYSTEMS RESPONSE TIMES

A. Call-in / Call-up Response Time: The Security Systems including central processing, input/output and peripheral equipment shall provide a call-up response time of max. 1.0 second. The call-up response time shall be defined from the time an intercom station is activated to the time the control consoles display the indicating signals and video associated, and allow the operators to verify identity and local conditions in response to the call-up.

B. Control Response Time: The Security Systems including central processing, input/output and peripheral equipment shall provide a control response time of max. 0.1 second. The control response time shall be defined from the time an operator activates a control switch to the time the controlled peripheral device executes the command such as unlocking of a particular door.

C. Supervisory/Trouble Response Time: The “SC” systems shall provide a supervisory response time of max. 1.0 second defined similarly to Alarm Response Times specified above.

D. "Acknowledge" and "Authorize Interlock Override" (AIO) Response Times: The “SC” systems shall provide an "AIO" response time of max. 0.5 seconds from the time the particular switch is depressed to the time the control consoles and “SC” is ready to execute a subsequent command.

E. Reset Response Time: The “SC” systems shall provide a reset response time of max. 3 seconds. The reset response time shall be defined from the time the reset button is depressed to the time the systems restart in fail-secure mode and the consoles are ready to execute a subsequent command.

F. Disaster Recovery Time: The “SC” systems shall provide a disaster response time of 240 seconds. The disaster recovery time shall be defined from the time the systems start-up following a complete database, application program and operating system failure. When the systems are recovered all functions shall be fully operational at all control consoles.

1.04 SECURITY & COMMUNICATION (SC) SYSTEMS - PRIORITIES

A. The “SC” systems shall be integrated/interfaced to process the signals according to the priority list below.

B. The “SC” systems and signal priorities shall be:
   1. Staff Duress Alarm
   2. Perimeter Alarm (if provided).
   3. Video Motion Alarm.
   4. Door/Gate/Roll-up door Alarm.
   5. Intercom Call.
   6. Miscellaneous utility and other alarms.

1.05 PROGRAMMABLE LOGIC CONTROLLER - SUBSYSTEMS

A. Provide a Central PLC System that will comprise of two (2) redundant CPUs and two (2) redundant power supplies. One CPU and power supply will be active while the second CPU and power supply are on standby. There will be a duplex module that switches automatically to the standby units if any errors are detected in the active unit.

B. Provide single CPU and power supply PLCs for each of the Local Control units. Provide all necessary expansion racks and power supplies to support all the necessary I/O, PLC modules and interposing relays for this project.

C. Provide all necessary PLC Ethernet and communication modules to network all the PLC together and communicate with all subsystems that will be integrated into the Control System such as Video and Intercom.

D. Door/Gate/Roll-up Door Control and Monitoring:
   1. Provide materials, labor, equipment and services necessary for a complete Door/Gate/ Roll-up Door Control and Monitoring (DCM) System as specified in this Section, under Division 28, "Operation Sequences". The Contractor shall provide all interfacing and integration work required for complete and functional systems.
   2. Provide cabling through new conduits as required to connect all door/gate/roll-up door control and monitoring devices shown on the Contract Documents.
   3. Refer to Manufacturer's Systems, Operation and Maintenance manuals for additional requirements regarding the Door/Gate/ Roll-up Door Control and Monitoring Systems.
   4. The following is a general diagrammatic description of work to be provided by the Contractor:
      a. "CONTROL INTERLOCKING" - control and monitoring from Central Control Center for:
         1) Intake Sally Port.
         2) Secured Vestibules from hallways to the Housing Unit Sallyport.
         3) Selected Corridors Doors.
   5. The Door/Gate/ Roll-up Door Control and Intrusion Detection System functions shall be implemented by interfacing and integration of the following systems:
      a. Door hardware, control and monitoring devices and systems.
      b. Programmable Logic Control (PLC) - Input/Output (I/O) Units for door control and monitoring required for all door devices required for this project.
      c. Central Processing System (CPS) and control consoles.
      d. Intercom and Paging System - As required to identify the location of intercom calling stations and associated doors, through signaling symbols shown on Contract Drawings.
   6. Provide global/group controls for emergency unlocking of doors, separately for each Sally Port as shown on drawings. Provide audible and visual adjustable time type "Reminder/Warning" signals at all times when the emergency unlocking function is enabled. Provide programming and control functions for selective group control and signaling as coordinated with Owner and Architect & Engineer.
   7. Definitions:
      a. Refer to Division 28 "Operation Sequences" specification.
      b. The following definitions of functions or indications shall apply to the descriptions contained herein.

1)	"Secure"	The door/gate/roll-up door is closed and locked. This is effected by monitoring the series connection of the latch bolt monitor switch and the door position switch.
2)	"Locked"	The status of a locking device when the latch bolt is fully

		extended. The device will not be locked until the door/gate/roll-up is closed.
3)	"Open"	The door/gate/roll-up door is "Open"/"NOT Secure".
4)	"Unlocked"	The status of a locking device when the latch bolt is partially or fully retracted.
5)	"Lock"	Control power is removed from the locking device as required to effect a "locked" mode. The nature of the locking signal or sequence is determined by the specific locking device. The description above applies to "Fail-Secure" locking devices.
6)	"Unlock"	Control power is applied to the locking device in an "unlocked" mode. Control may be by momentary or continuous application of power as dictated by the locking device.
7)	“Reset”	Activation of the "Reset" function shall place all locks in the emergency group in the locked mode. Doors may not be secured until they are physically closed as dictated by the specific locking device.
8)	"Interlock"	Interlocked doors will be controlled so that only a single door in the interlocked group can be electrically opened at one time. The systems shall include controls, connections and programming required for "controls interlock", "monitoring signals interlock" and "acknowledge/bypass interlock violation". The activation of the "acknowledge/bypass interlock violation” shall allow the control center operator to control all doors operating in a "monitoring signals interlock" mode. The control console shall include a security code protected "OVERRIDE-CONTROLS INTERLOCK" switch.
9)	"Manual Override"	All doors, gates, and roll-up doors shall include manual override via keys. Typically, all doors, gates, and roll-up doors shall be operable by officers assigned for operating at a particular door/gate/roll-up door. All signaling functions shall be enabled during manual operations.

c. Door Control and Monitoring System Functional Description:
   1) The control of all electrically operated doors shall be through reliable, factory tested controllers with a documented Mean Time Before/Between Failure (MTBF) of minimum 50,000 hours of operation. The controllers may be relay or programmable logic based units.
   2) The system shall provide supervision of equipment and wiring as shown on Contract Drawings. System equipment and wiring tamper, trouble and alarm signals shall be annunciated at the CCC.
   3) All doors shall be controlled from Central Control Center. All equipment shall be installed in maximum-security metallic consoles and enclosures.
   4) All power necessary for the Door Control and Monitoring System shall be connected through uninterruptible power supply and emergency generator.

E. Video Surveillance System (VSS):

1. Systems Selection and Control through Serial or Ethernet link to the VSS control computer and the Virtual Switching software for all cameras.
2. Video Surveillance System- Manual Control.

F. Intercom/Paging through serial interface to Intercom Paging Headend:
1. Station/substation selection.
2. Paging zone control.
3. Page exterior/interior.
4. All Page Center Control.

G. Dayroom Lighting Control through relay interface to Lighting Control Panels, coordinate with Electrical Contractor, Lighting Contractor, and Contract Documents.
1. For each Housing Unit (HU) Cells by floor in each Housing Unit
2. HU Day Rooms.
3. Multipurpose Room
4. Triage Room
5. Interview Room
6. Indoor/Outdoor Recreation

H. Utility Control through relay interfacing to electrical equipment or plumbing valves, coordinate with MEP contractor and all Contract Documents.:
1. Water supply for Housing Unit showers.
2. Dayroom TV power outlet.
3. ADA Cell outlets power.

I. Wired Duress Alarms:
1. Wired Duress displayed on TSC/GUI screens; Local control and CCC.
2. Call pushbutton shall be located in each officer station, each housing unit wall and each other areas shown on “ES” floor plans.
3. Upon initiating a call by pressing the pushbutton, an audio signal and flashing visual signal shall be annunciated at the officer station having jurisdiction, Housing Unit control console and site-wide Central Control Center. Coordinate as required.
4. The staff officer may silence the audible signal by pressing the TSC (Touch Screen Computer) icon switch associated with the call request. The visual indicator should change from an intermittent to a steady indication.
5. To reset the duress alarm switch, the staff member must go to the duress/panic alarm station and reset via the special key. The Duress Panic Alarm station and keyswitch may be separate units. Keying of duress alarm switches shall be approved by Architect and Owner.
6. Provide high light intensity type Duress/Panic Alarm Light ("DL") to assist the Security Officer in locating the duress/alarm "DPA" stations which originates an alarm at locations shown on the Contract Drawings. The "DL" lights shall be on stainless steel plates.
7. Provide Duress/Panic Alarm - Programmable Logic Control - Input/Output Units (PLC - DPA - I./O) as an extension of the PLC system specified under Control Systems.

J. Watch Tour System. Refer to Section 28 7000.

1.06 QUALITY ASSURANCE

A. The Contractor shall provide all work as required for correctional institutions. All equipment shall meet the highest reliability and performance standards established for the particular item of work. All equipment shall be vandalproof; provide enclosures, housings and security fasteners as shown on Contract Documents and as required by field conditions. All security electronics control equipment shall be lockable NEMA 12 enclosures unless they are rack-mounted in secure electronic equipment rooms. The Contractor shall provide the work based on the highest standards. The Contractor shall obtain written clarifications for any

interpretations which may require work that does not meet the above reliability and performance criteria.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

A. Contingent upon meeting all “performance”, “operation” and “reliability” requirements specified, the following products.
   1. Central Processing System (CPS) Computer: Dell – Power Edge server grade, Lenovo server grade, or HP server grade.
   2. Programmable Logic Controllers: Omron, GE, Allen Bradley, or approved equal.
   3. Touch screen monitors: ELO IntelliTouch (standing wave), 3M MicroTouch (near field imaging), DynaPro, or approved equal.
   4. Relays - Potter and Brumfield, Pheonix, GE Fanuc, Allen Bradley, or approved equal.

B. All control equipment manufacturers shall have been manufacturing products of similar nature as specified in Division 28 for a minimum of 20 years and certified that they will manufacturer replacement parts or system 100% compatible with the equipment or systems provided for a minimum of 15 years.

C. Substitutions shall be in accordance with the procedures specified in the Contract Documents.

2.02 ACCEPTABLE CONFIGURATIONS

A. The Security & Communication (SC) Systems shall be configured to meet the "Performance", "Reliability" and "Operational" requirements specified in Division 28.

B. For this project, the Central Processing System (CPS) is a combination of a Special Systems Computer and a PLC. The Contractor shall submit configuration, performance calculations and data, reliability data and operating details with the technical proposal. The Owner and Architect & Engineer reserve the right to reject configurations in their respective interpretation that do not meet Division 28 specifications. The Architect & Engineer’s interpretation of the Contract Documents shall be binding for the Contractor.

C. Control and Monitoring: Provide graphic user interface Touch screen computers installed in the Central Control Center, Training Control workstation and Local Control stations to monitor and manually control all gates, doors, and roll-up doors in the path of egress/access (vestibule and corridor doors) and all local control station locations as indicated on the Contract Drawings.

D. The Contractor shall provide Security and Communication (SC) Systems as shown and specified. Refer to Division 28 specifications and “SC” Contract Drawings.

2.03 COMPUTER SYSTEMS CONFIGURATIONS

A. Provide rack mountable Quad-Core RAID 5 Server grade Central Processing System (CPS) computers: Provide quad-core type servers configured with the devices listed below, at minimum for all equipment room locations. The servers shall be manufactured by Dell Computer Corporation Power Edge, or approved equals HP or Lenovo.
   1. Processors: Intel current generation quad core Xeon 3GHz processors, or higher with 4MB level 2cache.
   2. Random Access Memory (RAM): 4GB SDRAM, ECC/EDO, or better.
   3. Redundant Storage: Integrated SAS/SATA RAID 5 PERC 5/i controller with 16MB of cache. Provide at minimum three 2.5” SATA 80GB hard disks 10K RPM.
   4. For Detention Control System Computer, provide Backup & Disaster Recovery: Power Vault RD1000 Removable Disk Drive 160/320 GB with Dell Backup software. Interface with the Uninterruptible Power Supply System as required to ensure automatic orderly shutdown prior to depletion of battery power.
   5. Video: 1GB Video RAM, 2560x1600 dpi.
   6. Dual Network Interface Card: Pro Gigabit NIC PCI Ethernet.

7. Sufficient serial interfaces to meet design requirements as outlined on the Contract Drawings.
8. Monitor, Keyboard KVM: 19” LCD 1280x1024, Keyboard, and Mouse combination rackmount KVM console unit.
9. Power Supply: Dual, hot redundant. Provide dual thermostatically controlled fans.
10. Software, Configuration, Programming & Testing: Windows Server 2008 R2 or latest equivalent, Application Development Platform, Device Drivers, project specific application programming (complete and operational).
11. Warranty: Three (3) years, Gold, on-site, all parts and labor by manufacturer.
12. Programmable co-processor.
13. Input/Output Bus Controller.

B. Provide single processor, rack mountable, server grade computers with Intel current generation quad core Xeon processor, 500GB hard drive, 512KB cache, Dual Port 1GbE Nic, and 8GB Memory @1600Mhz, for all floor local control stations. All local control computers shall be networked to the headend computers at Center Control over 1GB fiber optic Ethernet LAN.
1. Keyboard & Navigation: Performance pro-keyboard with wireless mouse.
2. Monitor: 27” LCD touch control type terminal/monitors, 1680x1050 resolution.
3. Sufficient serial interfaces to meet design requirements as outlined on the Contract Drawings.

C. The Contractor shall submit calculations for RAM and Video RAM memory capacity and for hard drive capacity for all microprocessor based systems including Special Systems Computer and PLC. The Contractor shall base the RAM hard disk and controller (HDC) capacity calculations on specified systems response times, actual Operating System (OS), Application Programs (APS), SQL Compatible Relational Data Base (RDB), Graphic User Interface (GUI), AUTOCAD (CAD) files and operational requirements for this project.

D. Program the “Graphical User Interface (GUI)” Touch Control Security Systems Computer using a Supervisory Control and Data Acquisition (SCADA) program such as Indusoft, Wonderware, Cimplicity, or approved equal. Perform all initial programming and testing off-line to ensure that the transition to the server is minimum.

2.04 SYSTEM SOFTWARE

A. Software shall be supported by a real time, multi-user event driven operating system. The operating system shall support priority levels and shall support time-sharing for tasks of the same priority.

B. Utilities for file management, file backup and password security shall be an integral part of the operating system.

C. The applications shall include the following functions:
1. Graphic User Interface (GUI) type hierarchical menu system.
2. Program/Ladder Logic Editor, monitor and off-line testing.
3. Point monitoring (minimum 10,000).
4. Logical addressing, Image/Physical Location Addressing, Indirect Addressing through logical functions implemented including "AND, OR, INVERT, ON/OFF, TIMER, COUNTER, SEQUENCING", Indexed Addressing/Status Addressing, Symbolic/ASCII descriptor addressing.
5. Automatic or interactive output point control.
6. Memory map-graphic display.
7. Time dependent, channel, alarm and status reporting.
8. Printed journal log: Provide default programming for alarm printing only.
9. Magnetic media journal log: Provide default programming for alarm logging only.
10. Owner generated forms.

11. Real time status query for maintenance, diagnostics.
12. Management reports from historical data.
13. System security.
14. Online or offline database update with comments, symbols and instructions. Provide global search and editing for all application program functions. Provide sequential function chart type program editor and program monitor.
15. System diagnostics, both locally and remotely through telephone modem, through security firewall hardware (key-lockable switch) and software.
16. Color Graphic - Site plan/floor plan, graphic maps specified in Division 28 and shown on the Contract Drawings.
17. Offline and Online memory scanning and diagnostics in synchronous and asynchronous modes for execution of commands with special interrupt privileges.
18. Supervisory/watchdog processor.

2.05 PROGRAMMABLE LOGIC CONTROL (PLC) SYSTEM

A. The PLC shall be the product of manufacturer of PLC System engaged in the production of controllers for security application for a minimum of twenty (20) years. Only manufacturers with national distribution, national servicing and local parts outlets will be considered.

B. System software shall be contained in EPROM. RAM operation database shall be battery backed up. The program shall be developed for each controller on an individual basis. Furnish one spare EPROM for each controller, loaded with all the proper software and located with the controller.

C. The programming format shall be traditional relay ladder logic utilizing basic and advanced instruction sets for function generation.

D. The Main Central PLC shall be equipped with dual redundant processors. The local PLC controller shall be equipped with a processor, I/O modules, communication modules, power supplies, and accessories as required for a complete and functional unit.

E. Controller shall be configured to operate in a distributed processor environment and equipped with communications capability as required.

F. The I/O interface boards shall be standard printed circuit boards containing the necessary coding/decoding solid state circuits for communicating with the processor, LED indicators which display the status of each point and plug-in input/output modules.

G. The controller shall operate on 105 to 130 VAC, 60 Hz and contain an integral circuit breaker for overload protection. The primary power for all security control equipment shall be UPS power specified elsewhere in these Contract Documents. Coordinate with UPS power requirements with Electrical provider. The controller shall operate properly in environmental conditions of 0o to 60o C in up to 95% humidity (non-condensing). The controller shall conform to electrical noise standards of IEEE-472.

H. PLC program shall be provided to the Owner as specified in Section 28 0510 and as follows:
   1. Hard copy printout.
   2. Program on DVD.
   3. All programs stored on the hard drive of the programming data terminal only accessible through appropriate level of password protection.

I. The controllers shall provide all necessary logic functions, timing functions, memory, software, input/output points and communication capabilities for the operating features required to meet all of the requirements of the specifications.

J. The controller shall be general purpose in nature and not custom designed and built for this isolated application. The PLC shall be redundant and fault tolerant operation type. The controller shall be generally non-location specific in its construction. The controller shall be made location specific and operationally customized by installing EPROM with applicable

software, and making the I/O interface board's system specific and installing the proper I/O modules.

K. Logic functions shall include, but not be limited to, AND, OR and INVERT functions with sufficient levels to provide operating features required to perform all of the functions required by the specifications.

L. Timing functions shall include, but not be limited to, on-delay, off-delay, stepping and pulsing. Sufficient variations of programmable timing shall be available to provide all the operating features as required by the specifications.

M. The Central head PLC shall consist of redundant CPUs, redundant power supplies, hot standby simultaneous processing and function in Duplex and Simplex modes. It shall have a complete CPU, I/O, link and battery self-diagnostics function.

2.06 PROGRAMMABLE LOGIC CONTROL - INPUT/OUTPUT (PLC-I/O) UNITS

A. The Central Processing PLC and PLC-Input/Output (PLC-I/O) units shall be 100% compatible and be manufactured by the same manufacturer as part of an integrated series/family of products. The PLC / PLC-I/O units shall be connected to CPS via RS-232 / RS-422 / RS-485 ports. PLC / PLC-I/O units shall include interfacing to Security & Communication Systems as shown and specified.

B. The Central PLC units shall contain all hardware and software necessary for the systems specified under Division 28 to operate as an integrated system which meets the reliability and performance specifications specified.

C. Provide PLC-I/O units as required for the Security & Communication Systems specified in Division 28.

D. The PLC-I/O units shall be configured for:
   1. 24V DC signal threshold: The PLC's provided for this project shall operate with "high signal current/low impedance" to ensure that external RFI/EMI influences do not result in false signaling and controls. The PLC-I/O's shall include time delays to ensure that short spikes will not result in false signals. The PLC-I/O's shall be configured for RFI/EMI immunity similar to electromechanical relays operating at 24 volts.
   2. "Watchdog" circuits and relays as required to ensure that the system fails in "fail secure" condition, 100% of times when a system malfunction or power failure occurs.
   3. "Fail Secure" mode of operation during start-up and diagnostics.
   4. Built-in self-diagnostics and programmable "Reminder Operator Signaling".
   5. Built-in status indicators for power supplies, memory and communication ports.
   6. I/O drivers for connecting remote I/O devices which may be up to 10,000 ft. from control equipment.
   7. Multiple levels of "AND, OR, INVERT, ON/OFF, DELAY, COUNT UP/COUNT DOWN COUNTERS, ON DELAY/OFF DELAY, RETENTIVE TIMERS, SEQUENCING, COMPARE, EQUAL, GREATER THAN (OR EQUAL), LESS THAN, LIMIT TEST, COMPUTER, AVERAGE, MOVE, FOR NEXT, JUMP, RETURN, ONE SHOT FALLING, ONE SHOT RISING, SEND/RECEIVE MESSAGE, STRING CONCATENATE, STRING EXTRACT, EXTEND BUFFER" functions as required for implementation of redundant, multiple station control, signaling and interlocking.
   8. Communication ports for Ethernet 10/100/1000 Mbps, RS232, RS422 and 20MA connectors.
   9. Supervision of all circuits – input and outputs to determine faulty wiring from open contacts.

E. PLC input/output units shall be manufactured by the PLC CPU manufacturer.

F. Remote I/O units may be distributed throughout the facility to reduce wiring.

2.07 DOOR CONTROL AND MONITORING EQUIPMENT

A. The Contractor shall coordinate the requirements of door hardware and control/monitoring requirements described in this section.

B. The door hardware and control shall include:
   1. Concealed door position monitoring switches.
   2. Concealed latch monitoring switches.
   3. Fail secure locks.
   4. Manual emergency key type operation, from both sides.
   5. Interlocking with other sally port doors/gates/roll-up doors in the configurations shown on the floor plans, through the Central Processing and Programmable Logic Control (PLC) systems specified in this section.

2.08 VEHICLE SALLYPORT ROLL-UP DOOR CONTROL AND MONITORING

A. The roll-up doors at the main vehicular sallyport, with its associated controller, are provided by another trade that is specified elsewhere in these specifications. The control and monitoring of these doors are from the Central Control and Local TSC controller. The SSC shall coordinate all control requirements with the door provider and the electrical contractor. Controls for electrical doors shall be as shown on Contract Drawings and as specified elsewhere and shall perform as follows:
   1. Control Functions – Central Control and Local Control console shall operate doors as shown on the Contract Drawings.
   2. The entry and exit to the gate shall be “controlled in and out”.
   3. Door opening is initiated by pressing the OPEN icon.
   4. Door is closed once vehicle clears vehicle detection hardware.
   5. A STOP icon allows the doors to be stopped in any position.
   6. Resuming Movement - Door movement may be resumed in either direction by pushing the appropriate button.
   7. Door movement may be reversed in either direction by pushing the appropriate icon. The control system automatically stops the gate, pauses, and then causes the gate to travel in the opposite direction.
   8. All wiring shall be in underground conduit.
   9. Provide all required Open and Close Loops and related equipment required for proper operation as shown on the Contract Drawings.
   10. Coordinate all performance functions necessary; all control wiring and all conduit requirements with all appropriate trades.
   11. Refer to operational requirements within the specification as well as Contract Drawing requirements.
   12. Communications between the door location and Center control shall be provided by weather proof intercom stations located at the entry and exit locations near the door and as outlined on the Contract Drawings. On initiation of the intercom stations the local camera shall provide video by automatic call up of this entry door camera with a spot monitor located at the Center Control console. Coordinate audio and visual requirements with the Owner.

2.09 LIGHTING AND UTILITY CONTROL

A. Provide all necessary software and interface hardware to control from the TSC local control console GUI screens the Dayroom Lighting for and water supplies for all HUs and the lights, showers and toilets for individual cells for Housing Unit cells.

B. Security Contractor to provide I/O and interposing relays as necessary to interface to lighting control panels (Lighting Division 26 contactor), TV power, telephone power, and plumbing control valves provided by other trades specified elsewhere in these specifications.

2.10 ELEVATOR INTERFACE

A. Provide all necessary software and interface hardware between the PLC system and the elevator system to allow for interface. Elevator cab doors shall not open unless valid card read from the associated card reader. Provide ability for override of elevator control from Central Control Touchscreen control station.

2.11 RELAYS

A. Provide UL-listed relays where required to interface to high power devices and where electrical isolation is required in high power circuits.

B. Relay coils shall be 24VDC.

C. Relay contacts shall be sized as required for min. 100,000 hours of operation under normal conditions of use. The contacts shall be rated for 50% greater amperage than anticipated load.

D. Provide damping diodes and devices as required to support EMI/RFI generation.

2.12 TOUCH SCREEN OPERATOR INTERFACE TERMINAL

A. The touch screen shall be the product of a manufacturer engaged in the production of touch screens for industrial applications for a minimum of five (5) years.

B. Provide minimum 27” color LCD touch screen monitors for each operator computer station including the Center Control, Training Control, and Local/Housing Unit stations.

C. Provide all mounting hardware and cabling for each console-mounted touch screen.

D. The touch screen monitors shall meet the following minimum requirements:
   1. Resolution: 1920 x 1080’ (native at 60 or 75 Hz).
   2. Colors: 16.7 million.
   3. Brightness: 300 cd/m2.
   4. Horizontal 170º total Vertical 160º total
   5. Response Time: 2ms
   6. Input Video: HDMI, 15 pin D-Sub, DVI-D, DVI-I and VGA.
   7. Power Supply: Input (line) voltage - 100-240 VAC, 50-60 Hz, Monitor Input Voltage - 12 VDC at 3.75 amps.
   8. Power Distribution: 40 watts (typical).
   9. Temperature Operating: 0 C to 35 C.
   10. Humidity: 20% to 95% non-condensing.
   11. Agency Approval: UL/cUL, FCC/IC/VCCI/C.
   12. Antiglare Surface Treatment.
   13. Mounting Options: 100mm or 75mm VESA mount, rear mount monitor only, or with brackets, panel cutout.
   14. Warranty: 3 years for monitor.

2.13 ALARM AND STATUS REPORTING

A. Alarm annunciation may be selectively steered to any combination of control consoles. Alarms may be individually prioritized for each console and alarms above a given priority shall cause an audible alarm.

2.14 JOURNAL LOG

A. The system shall have the capability to selectively log all events in the system to both a printer and to CPS disk storage system. All log entries include a time stamp, an event descriptor and, when applicable, an operator.

B. Alarms logged shall include information presented to the consoles and the system shall create a corresponding acknowledgment message when the alarm is acknowledged.

C. The printer shall support multiple fonts and expanded print to highlight alarms. The descriptor printed for each state of a point may be individually selected.

D. The magnetic media journal shall serve as system archival storage from which management reports may be generated or the printed journal recreated. The system shall support two journal storage devices to provide long-term removable storage and short-term fast access storage.

E. Reports shall run concurrently with, and at a lower priority than, the critical system functions and shall not affect the response time of alarm annunciation.

F. Reports shall be selected from a menu of predefined report formats which shall include:
   1. All activity between a selected start time/date to stop time/date.
   2. Non-circuit activity between a selected start time/date to a stop time/date.
   3. Circuit activity between a selected start time/date and a stop time/date.
   4. Activity for a group of points between a selected start time/date and a stop time/date.
   5. All Watch Tour reports.
   6. All control console activity.
   7. All supervisory circuit activity.
   8. All activity for a group of points.
   9. All duress alarms.
   10. All take-over commands.
   11. All fire alarms.
   12. All general alarms.
   13. All vehicle sallyport door openings.
   14. Other user defined groups.
   15. All incident reports.

2.15 SYSTEM SECURITY

A. The integrity of the system shall be protected by a system of operator passwords, access levels, and audit trails.

B. Each operator is assigned a password and access levels. When an operator logs on the system, he will be asked for his operator name and password. If these match, he will be allowed to perform any function allowed to his access level. Each operation is included in the system log.

C. In addition to the logging of an operator entry, the system shall record any transaction which will affect the operation of the system.

2.16 SECURITY NETWORK ACCESS LAYER SWITCHES

A. The Access Layer Switches for the Security Network shall meet all of the following specifications and have all of the following capabilities:
   1. Rack-mounted.
   2. 10/100/1000 rated full duplex auto MDI/X access ports with full wire speed non-blocking switch fabric, sized according to the number of outlets required for the network as described by the Contract Drawings and Specifications. No more than 80% of access ports shall be populated at initial startup.
   3. Four (4) 10Gbps SFP+ uplink ports
      a. Provide one (1) 10Gbps fiber transceiver for each uplink between each access layer switch and the core network switch.
      b. In locations where there are two (2) or more access layer switches stacked, provide two (2) total 10Gbps fiber transceivers for the switch stack so that a single switch or transceiver failure cannot cause the entire switch stack to disconnect from the core.
   4. af and 802.at PoE and PoE+ support on all ports.

a. Each switch shall be capable of providing at minimum full rated 15w PoE on every port simultaneously.
b. Distribute PoE+ and PoE++ loads across switches so as not to leave any switch with spare switch ports for which there is no remaining PoE capacity.
c. Provide power supplies in capacity and quantity as required to meet these PoE requirements.
d. Submit calculations proving that all switches will be capable of providing the required PoE power, and that there will be spare capacity to provide at minimum full rated 15w PoE on all spare ports.

5. Full duplex link aggregation of at minimum 4 links.
6. Fixed configuration stackable design. Provide configuration and provide stacking modules and stacking cables so that a single switch failure cannot disrupt the function and connectivity of any of the remaining switches.
7. Field-replaceable power supplies and fans.
8. OSI model layer 2 switching with configurable management addresses and at minimum layer 3 static routing.
9. IPv4 with support for simultaneous IPv6 operation.
10. At minimum 4096 independent VLANs.
11. At minimum four (4) hardware egress queues per port.
12. Quality of Service (QoS) and Class of Service (CoS).
13. Remote management and configuration.
14. IGMP Snooping with, at minimum, 500 IGMP groups.
15. The following security and authentication protocols: 802.1X, RADIUS, Port Security, DHCP Snooping, Dynamic ARP Inspection, Port-based Access Control Lists, SSHv2, SNMPv3, BPDU Guard, Root Guard.
16. Rapid Spanning Tree Protocol (RSTP) and Multiple Spanning Tree Protocol (MSTP).
17. Support for, or in the case of layer 3 protocols the ability to work with, all protocols necessary for the entire network, including but not limited to: TCP/IP, UDP, IPX/SPX, TFTP, Telnet, RMON, LACP, 802.1D, 802.1P, 802.1Q, NTP, and all corresponding protocol versions for IPv6 support.
18. Perpetual software licensing such that there shall be no cost to the Owner for the perpetually continuing full functionality of the network switches as configured at substantial completion. “Software-Defined Networking” license options are not required.
19. Security Network Access Layer Switches shall be Cisco Catalyst 9200 series or approved equal by HP, Extreme Networks, or Juniper. Provide fixed configuration models stacked as required to meet the port count, throughput, and PoE requirements of all locations. Refer to the Contract Drawings.

2.17 SECURITY NETWORK CORE LAYER SWITCH

A. The Core Layer Switch for the Security Network shall meet all of the following specifications and have all of the following capabilities:
1. Rack-mounted.
2. Modular configuration with at minimum three (3) module slots. Module slots shall be populated with all of the following:
a. Supervisor engine that is capable of supporting all requirements listed here.
b. Minimum 12-port 10Gbps SFP+ line card, or as required to meet the port count requirements stated below – whichever is greater. Provide type and quantity of slot modules as required so that there is no oversubscription of the ports, and full rated bidirectional bandwidth is available on all ports simultaneously. Ensure that the supervisor engine shall support this requirement as well.
c. 48-port PoE-enabled RJ45 port line card.

3. 10/100/1000 rated full duplex auto MDI/X access ports with full wire speed non-blocking switch fabric and supervisor engine, sized according to the number of outlets required for the network as described by the Contract Drawings and Specifications. No more than 80% of access ports shall be populated at initial startup.
4. 10Gbps SFP+ fiber transceivers populated for all connections to access layer switches. All required Gigabit Ethernet standards shall be supported, including but not limited to 10GBASE-SR and 10GBASE-LR. No more than 80% of SFP+ ports shall be populated at initial startup. Provide additional modules, as required.
5. af and 802.at PoE and PoE+ support for at least full rated 15w PoE on every port, as required.
6. Provide redundant (N+1) power supplies which are each individually capable of supporting the entire power requirement of the chassis as per the requirements here. No single power supply failure shall result in the switch losing power or functionality.
7. Full duplex link aggregation of at minimum 4 links.
8. OSI model layer 2/3/4 express forwarding.
9. IPv4 with support for simultaneous IPv6 operation.
10. All industry standard dynamic routing protocols including but not limited to: OSPF, OSPFv3, RIPv2, and RIPng.
11. Policy-based Routing.
12. IP Multicast routing protocols including but not limited to Protocol Independent Multicast (PIM).
13. At minimum, 4096 independent VLANs.
14. Inter-VLAN Routing.
15. At minimum four (4) hardware egress queues per port.
16. All QoS capabilities including but not limited to the following: per-port QoS, per-port per-VLAN QoS, Strict Priority Queuing, DSCP and ToS classification, input and output policing, congestion avoidance.
17. Remote management and configuration.
18. IGMP Snooping with, at minimum, 500 IGMP groups.
19. The following security and authentication protocols: 802.1X, RADIUS, Port Security, IP Source Guard, DHCP Snooping, Dynamic ARP Inspection, Port-based Access Control Lists, SSHv2, SNMPv3, BPDU Guard, Root Guard, RACLs, VACLs, PACLs, PVLANs, Control Plane Policing.
20. Rapid Spanning Tree Protocol (RSTP) and Multiple Spanning Tree Protocol (MSTP) with PortFast, UplinkFast, and BackboneFast.
21. Support for all protocols necessary for entire network functionality including but not limited to: TCP/IP, UDP, IPX/SPX, TFTP, Telnet, RMON, LACP, 802.1D, 802.1P, 802.1Q, NTP, HSRP/VRRP/GLBP, and all corresponding protocol and standard versions for IPv6 support.
22. Perpetual software licensing such that there shall be no cost to the Owner for the perpetually continuing full functionality of the network switches as configured at substantial completion. “Software-Defined Networking” license options are not required.
23. Security Network Core Layer Switches shall be Cisco Catalyst C9404R with C-9400-SUP-1XL, C9400-LC-24XS, and C9400-LC-48P or approved equal by HP, Extreme Networks, or Juniper. Provide modular configuration models with all components, accessories, and licenses as required to meet the port types, port count, throughput, and PoE requirements of all locations.

2.18 NETWORK FIBER OPTIC CABLE

A. Refer to Division 27 specifications.

2.19 DISTRIBUTION AND PATCH CABLE

A. Refer to Division 27 specifications.

2.20 CAT-6 PATCH PANELS

A. Refer to Division 27 specifications.

2.21 FIBER OPTIC PATCH PANELS

A. Refer to Division 27 specifications.

2.22 SELF DIAGNOSTICS

A. The system shall have the capability to detect and annunciate the failure of any subsystem. When a failure is detected, the system shall perform on-line diagnostics to pinpoint the failure and recommend corrective procedures. These diagnostics can also be checked through the telephone modem.

2.23 CABLING REQUIREMENTS

A. Contractor shall be responsible for sizing all cables and conductors to minimize voltage drop based on anticipated loads of each circuit. Voltage drop shall not exceed the manufacturers' of the equipment being supplied recommendations or a maximum 5% voltage drop.

B. Input cables shall be a minimum 18 AWG copper stranded cable; output cables 16AWG and shall be shielded twisted pairs, 600 volt, 90ºC UL listed if installed in cable tray, shall be VNTC cable tray rated. If installed in conduit, Small Diameter Neoprene (SDN) 600 volt, 90ºC type TC cable.

2.24 HARDWIRED DURESS BUTTON AND LIGHT

A. Duress/Panic Alarm call-in switch shall be flush in all finished areas mounted security type installed as shown on the Drawings. Switch shall be momentary contact type. Switch assembly shall be 5210 series with key reset, maximum security, vandalproof, pushbutton as manufactured by Dortronics Systems Inc or approved equal.

B. Duress Lights shall be mounted above each door with Vandal Resistant Wire Guard. Duress lights shall be Potter blue colored strobe light with white housing, model CS-24WBW, or approved equal.

2.25 CALL BUTTONS

A. Call button switch shall be flush in all finished areas mounted security type installed as shown on the Drawings. Faceplate shall be stainless steel single gang plate. Switch shall be momentary contact type. Switch assembly shall be model CIB2 as manufactured by Quam, or approved equal.

2.26 DOOR RELEASE PUSHBUTTONS

A. Provide heavy duty door release pushbuttons at locations shown on the Contract Drawings.

B. The door release pushbuttons shall be interfaced to the PLC control system for the release of the associated door locks.

C. Provide heavy duty contacts rated 5 amps at 24 volts, UL listed.

D. Provide black button engraved "PUSH TO RELEASE" ¼" thick aluminum backplate.

E. Coordinate mounting with the Architect and the custom millwork.

F. Provide all necessary backboxes and accessories.

G. The door release pushbuttons shall be manufactured by Dortronics Model WR5276-HD29 Series, or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Contractor shall install in conduit, all cable and wiring. Also provide all connectors, backboxes and appurtenances, and make final connections to the control, locking and detection system

hardware as required to provide a fully functional locking, control and monitoring functions as defined in Div. 28.

B. Power interruptions or power transients shall result in a fail-secure door lock status.

3.02 ADJUSTING, TESTING AND CLEANING

A. General:
   1. Upon completion of the work, remove excess debris, materials, equipment, apparatus and tools, and leave premises clean, neat and orderly.

B. Testing:
   1. Component Testing - Each separate component of the Security System door/utility control and monitoring system shall be tested individually. In particular, each printed circuit board shall be tested for circuit continuity and circuit isolation. All electronic components shall be operated for the time duration required to identify product failures and the board shall be completely operationally tested. This testing shall be done at the site of the control equipment manufacturer.
   2. Factory Testing:
      a. All components of the Door Control and Monitoring System shall be operationally tested together with the exception of the end devices. At this time, all components and interconnecting wiring shall be complete and fitted with their respective plug.
      b. The Architect, Engineer and Owner have the option of witnessing all factory tests. Notify Architect, Engineer and Owner at least 4 weeks prior to system testing.
   3. Site Testing:
      a. All security control equipment, including computer systems, PLC, locks, monitoring devices, and integration of all security equipment. All inputs and outputs to the PLC shall be fully tested by the Contractor. A written report shall be issued, witnessed by the Owner's Representative if requested.
      b. All communication links between PLC and workstation computers shall be fully tested as well as the redundant features of the Central PLC and CCC computers.
      c. All test reports shall be issued to the A&E prior to FINAL ACCEPTANCE.
   4. The commissioning of the lighting control, and miscellaneous electrical utility controlled power circuits shall be a joint effort between the Division 28 and Division 26 contractors.
   5. Refer to Sections 280500 and 280510 for additional testing and FINAL ACCEPTANCE testing requirements.

END OF SECTION

SECTION 28 5000
INTERCOM AND PAGING SYSTEM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

B. Refer to all Contract Drawings and specification sections listed in Section 28 0500 and 28 0510 for additional requirements.

C. Refer to Section 28 0530 for Operational Sequences.

D. Refer to Division 26 and 27 and the Electrical drawings for coordination requirements for power and infrastructure.

1.02 DESCRIPTION OF WORK

A. Provide Intercom and Paging (IPA) System as shown on the Contract Drawings. The IPA system integration shall include duplex voice communication between the master intercom stations and all substations.

B. Site wide integration shall include Internet Protocol (IP) via the security network. Systems integration shall include IPA, Central Processing System/Programmable Logic Control System interfacing required for implementation of signaling and controls in Section 28 0530.

C. The IPA system shall include multiple voice channels/paths as required for simultaneous operation of all control consoles provided under this contract, in conjunction with each locally controlled area and required site wide IPA communication specified.

D. The work provided by the contractor shall include the following:
   1. All Intercom and Paging System components, including conduit, cabling, interfacing, connections and programming for the multiple master intercom and paging stations as shown on Contract Documents.
   2. All Intercom and Paging System components, speakers, horns, conduit and cabling for all control station locations.
   3. The headend and control system shall be expandable.

E. The Intercom and Paging System shall include functions such as "ALL CALL/EMERGENCY PAGE," "GROUP-CALL," and other similar combinations. These shall be programmed at no charge to the Owner upon acceptance testing of the facility and direction by the Owner.

F. Provide separate volume controls and amplifiers for each zone. The volume controls shall be located in the Security Equipment Room.

G. Provide coordination with other trades and contractors as required for a complete, functional and trouble-free Intercom and Paging System.

H. Provide weather proof intercom sub-stations mounted in a dual height pedestal located at the entry and exit locations of the perimeter gate and entry to the intake vehicle sallyport as outlined on the Contract Drawings.

I. Provide all labor, materials, equipment, testing and services necessary for and incidental to furnishing and installing intercom system. Provide as shown on Contract Drawings stainless steel tamper-proof Sub-Stations at each location shown. Provide power supplies, audio power amplifiers, backboxes and all required system accessories. Provide cabling run, as required, through the site communications duct bank as shown on Contract Drawings. Provide cable connector modules, weatherproof splice bodies and any appurtenances required for a fully functional system.

J. Coordinate cabling, system components and their arrangements electrically and mechanically. Provide 6 ft. cable loops in all manholes for future connections.

K. Provide Sound Detection and Audio Monitoring through the Master Intercom Stations.

L. Provide interface to the PLC Security Control Systems.

M. Provide line fault indication for all circuits.

N. Intercom and Paging Systems should conform to the following:
   1. Intercom: The Intercom System shall be interfaced with the Security and Control System to allow the various control center operators to communicate directly through the Touch Control Screen and Graphic Control Screens, to substations located throughout the facility as well as between Control Centers. Intercom Stations shall be hands-free operation from the remote call-in stations, push-to-talk at control stations, stainless steel construction, and flush mounted.
   2. Paging: Paging shall be provided throughout the facility. Local Control Consoles shall include paging for their area of jurisdiction. The Master Control Center shall include global paging for the entire institution and zoned paging for each department/jurisdiction. Integration with new VOIP telephone system shall be provided to allow remote paging from VOIP telephones in various areas of the facility to include Administration, Medical, Intake, and elsewhere this shall include global paging for the entire institution and zoned paging for each department/jurisdiction..
   3. The system shall include the following functions:
      a. Door control intercom.
      b. Reception intercom.
      c. Intercom station audio monitoring.
      d. Zoned public address.
      e. Output and event response control.
   4. The system shall integrate with the following other security and communication systems to form a comprehensive facility management network:
      a. PLC door control system.
      b. Touch screen control system.
      c. Video Surveillance system.

1.03 SYSTEM OPERATION

A. Intercom Master Station General Operation:
   1. Master Intercom Station shall include a minimum 2-line LCD display to provide alphanumeric descriptions of functions, station and device names, and current activity. Function key labeling to change depending on the location within the menu structure or options available to the operator.
   2. Master station shall normally display the identity of the top two calls in its call request queue. Call identity shall include the device ID number and/or an alphanumeric descriptor. Descriptor shall be up to 12 characters.
   3. The master station display shall indicate the total number of calls currently in its queue. Scroll keys shall enable the master station to view all calls in the queue.
   4. Master station to display, in a defined area, the number of acknowledged calls, and number of stations removed from service or monitor points in bypass mode.
   5. Master stations, through their command functions, to have the ability to:
      a. Answer calls.
      b. Place calls.
      c. Place calls on hold.
      d. Transfer calls to another master station.
      e. Place conference calls.

f. Place group calls.
g. Make zoned public address announcements.
h. Monitor intercom stations.
i. Independently adjust each station's volume level.
j. Remove stations from service.
k. Recall the last station with a single control.
l. Adjust display back lighting.
m. Select 12 or 24-hour clock display.
n. Adjust the step rate for switching between monitored stations.

6. Provide for volume adjustment of master station and intercom levels shall be controlled during communications. Each station's volume level shall be independently software-controlled. Level settings shall remain in effect until modified by a future adjustment.
7. Master stations shall include the ability to be placed in an unmanned mode which automatically routes all of the associated call handling functions to a pre-defined secondary master station.
8. The system shall automatically release the speech path if dialing is not completed within a pre-programmed time period, typically five seconds.

B. Intercom Substation General Operation:
1. Depressing an intercom station's call push-button shall place a call request in the queue of the master station or stations assigned to receive that station's calls. Calls shall be queued in order of priority level associated with the intercom station and time the call was placed.
2. Calls not answered within a pre-programmed time shall place a secondary call request to an assigned master station.

C. Call answering at an intercom master station shall provide for the following:
1. Intercom master stations shall be able to answer the top call request in its queue by depressing the 'Next' function key. At the completion of the call, the 'End' function key shall close the communication link and remove the call from the queue.
2. Subsequent calls may be similarly handled for the remaining calls in the queue.
3. Queued calls may be answered out of sequence by scrolling through the queue to the desired call. The selected call to flash on the display and shall be answered by depressing the 'Enter' key. 'End' key shall close the communication link, remove the call from the queue and return the master station display to the top of the queue.
4. A call that is currently connected to a master station shall display that the call is connected, the type of device connected, and the identity of the connected device.

D. Voice Communication shall provide for the following:
1. Telephone handset voice communication between intercom master stations shall be full duplex.
2. Open voice communications between intercom master stations shall be automatically switched half duplex with press-to-talk override.
3. Voice communications between intercom master stations and intercom stations shall be automatically switched half duplex with press-to-talk override.

E. Station monitoring shall provide for the following:
1. Master stations shall be able to monitor an individual intercom station or a pre-defined group of intercom stations.
2. System shall permit establishing as many station monitor groups as there are unused station ID numbers.
3. Each master station shall individually control the rate at which stations in the monitor group are sequenced through.

F. Paging shall provide for the following:
   1. Master stations shall have the ability to page to pre-determined groups of intercom stations and/or loudspeaker zones.
   2. Paging selection shall be made by selecting the page function and a group or zone from the selection list. Alternately, the zone number may be entered after the page function has been selected.

1.04 FUNCTIONAL REQUIREMENTS

A. System shall be capable of assigning station and group numbers within a minimum range of 0 to 9999.

B. System shall be capable of assigning an aphanumeric description for each device, group, zone, etc. with a minimum of 12 characters and spaces.

C. All intercom station field wiring shall be supervised for short circuit and open circuit faults.

D. All system boards shall include self-diagnostic functions for complete operational and communication testing.

E. All system boards and devices shall be able to be inserted or removed from service while the system is fully operational. Other system activity not directly related to the board insertion or removal to not be affected.

F. System diagnostics shall include the ability to test system communications and devices from the service, administration, and control computer.

G. System shall include the ability to make on-line changes to the system configuration.

H. System shall include logging functions for system activity and system maintenance.

I. System shall include the ability to print, through an optional printer, activity and maintenance logs.

J. On-line factory support shall be available through a modem connection to the service, administration and control computer.

1.05 PERFORMANCE REQUIREMENTS

A. System frequency response: 300 to 3,500 Hz.

B. Intercom station output: 82 dB SPL at 3 feet with 82 dB SPL input at face of transmitting station.

C. Maximum time from call placement to annunciation at intercom master station: 1.0 second.

D. Maximum time to complete call connection upon receipt of command from intercom master station: 1.0 second.

E. All system equipment to comply with the radiation limits for Class A digital devices of FCC Rules Part 15, Subpart B.

1.06 ELECTRICAL POWER REQUIREMENTS

A. Provide all power as required. Coordinate all power and infrastructure requirements with the Division 26 Contractor.

1.07 QUALIFICATIONS

A. Contractor shall be qualified and certified by the manufacturer prior to installation and programming.

1.08 QUALITY CONTROL

A. Intercom and Paging System components shall meet the requirements of all applicable codes and standards. All equipment shall be of maximum-security correctional grade.

B. The Contractor shall strictly adhere to the installation instructions provided by the system manufacturer and shall provide certification reports from the manufacturer's Representative that all installation instructions have been satisfactorily complied with.

C. All equipment shall be Underwriters Laboratory/CSA listed.

1.09 RELIABILITY

A. Provide Intercom and Paging System with mean time before/between failure of minimum 36,000 hours.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Intercom and paging equipment shall meet all functional and integration requirements necessary for interface to other systems. Subject to compliance with the “PERFORMANCE,” “OPERATION” and “RELIABILITY” requirements specified, provide products by:
   1. Harding MicroComm DXL,
   2. Or Approved equal.

2.02 INTERCOM CENTRAL EXCHANGE

A. Provide Facility Paging Exchanges, hands-free type Master Stations, Substations Service, Administration and Control (SAC) Computer, and card cages as required.

B. The following specifications of the Intercom and Paging System apply to all system components provided.

C. Provide all control, switching logic, signaling and operating features listed in this specification.

D. All circuits shall be located on printed circuit boards which slide in to the Central Exchange mainframe and/or I/O card cages.

E. The Central Exchange shall be configured to provide the following capabilities:
   1. Programming from Security Electronics Room and Central Control Center Master Stations, battery-backed protection of user program, multiple answer codes, alarm call, all call, priority call, group call, auto callback, conference call, restricted access, external speaker page, audio monitoring, stations and minimum 25 voice channels as required.

F. Provide wall mounting hardware, printed circuit boards and modules as required for specified system functions.

2.03 INTERCOM SYSTEM

A. The Intercom System shall be a hybrid IP Intercom System. The system shall feature traditional analog intercom stations connected to Networked Exchange units. All audio and control signals shall be transmitted by Ethernet Network between Intercom Exchange units. Exchange units shall be provided where required to take advantage of the existing individual homerun cables to the equipment rooms. The system shall be compatible both with analog and fully IP connected intercom stations. The system shall provide all functions found in traditional intercom systems.

B. Provide new Master Stations, Substations, and exchanges as shown on Contract Drawings.

C. The following specifications of the Intercom System apply to all system components provided.

D. Provide all control, switching logic, signaling and operating features listed in this specification.

E. The exchange units shall be configured to provide the following capabilities:
   1. Programming from equipment rooms and master intercom stations, battery-backed protection of user program, multiple answer codes, alarm call, all call, priority call, group call, auto callback, conference call, restricted access, audio monitoring, stations and minimum 25 voice channels as required.

F. Provide rack mounting hardware, printed circuit boards and modules as required for specified system functions.

G. Voltage regulation circuit board, transformers, subscriber cables, subscriber (i.e. station) circuit boards, voice channel circuit boards, processor circuit boards, optional feature circuit boards (all call, group call, alarm call, etc.), logic circuit boards, interface boards and all accessories as required to provide the capabilities described in these specifications. Provide terminal boards, wiring accessories and all appurtenances required for a fully functional and trouble-free system.

H. The Intercom System provided under this contract shall include all hardware and software required for hands-free conference mode operation of selected groups of master stations and substations specified by the Design Professional and Trumbull County and as represented by the contract documents.

I. Provide number of simultaneous talk paths/trunks/busses as required to meet project demands.

2.04 COMMUNICATION CONTROLLERS

A. Digital Communication Controllers to each form an intercom exchange capable of independent local operation. Exchange capacity to be increased by connecting up to four Digital Communication Expanders to each Communication Controller (CC).

B. Multiple CC's to be networked together via digital audio trunks and/or Ethernet data networks to form larger systems. VoIP enabled systems shall utilize IEEE 802.1p/Q Quality of Service (QoS) compliant Ethernet networking equipment.

C. Each CC to include:
   1. Process Control Card (PCC)
   2. Master Control Card (MCC)
   3. Two Station Control Cards (SCCs)
   4. Optional internal PCI card (Lonworks or VoIP accelerator card)
   5. Front panel keypad/display for system setup and maintenance.
   6. 110 VAC, 60 Hz power supply for internal functions.

D. Process Control Card:
   1. Process Control Card to contain system configuration and data, control exchange operations and switching, and provide exchange network ports. Process Control Card to include:
      a. USB network ports for exchange expansion.
      b. Ethernet network ports for system expansion and external control by touch screen computers and graphic control panels.
      c. Fiber optic or copper digital audio trunk ports. (not required for VoIP over Ethernet audio trunking).
      d. Two serial ports.
      e. Internal modem for transmitting and receiving data over a telephone line.

E. Master Control Cards:
   1. Include ports for any combination of two intercom or telephone set master stations.
   2. Include two line level audio inputs with status and control.
   3. Include two line level audio outputs with status and control.
   4. Convert incoming audio signals to digital format and outgoing signals to analog format.
   5. Intercom master station audio, press-to-talk and hook switch status transmitted over two single shielded pair cables with wiring supervision to detect open circuit and short circuit faults.
   6. Telephone set master station functions transmitted over a single wiring pair.

F. Station Control Cards:

1. Each provide sixteen half-duplex intercom station ports which can be employed in adjacent pairs for full duplex devices.
2. Provide an interface for intercom stations. Units to convert incoming audio signals to digital format and outgoing signals to analog format. Each channel to monitor the status of up to two (2) switches associated with each intercom station.
3. Each card interfaces with 16 half-duplex channels. Each channel includes a separate audio power amplifier for non-blocking call operation and sixteen (16) independent software controlled volume settings.
4. All station audio, switch, and power functions on 400-Series and 401-Series cards to be transmitted over a single shielded pair cable with supervision to detect open circuit and short circuit faults or audio and switch functions on 300 Series (Generic Intercom) station control cards to be transmitted on separate wiring pairs.

2.05 COMMUNICATION EXPANDERS

A. Communication Expanders (CE) provide master station and intercom features similar to the CCs to facilitate exchange expansion. Each CE can support two intercom or telephone master stations and 32 intercom station.

B. Each CE to include:
1. Digital audio trunks and signal processing.
2. Unrestricted communications within each exchange
3. Process Control Card (PCC) without exchange control or network functions.
4. Master Control Card (MCC).
5. Two Station Control Cards (SCCs).
6. 110 VAC, 60 Hz power supply for internal functions.

2.06 PAGING ZONE EXPANDER

A. Provide a paging zone expander to provide multiple paging zones for the intercom system. Paging zones shall be established with coordination from the ADC. Provide the number of Page Zone Expanders as required for a complete and functional system.

B. The Paging Zone Expander shall include:
1. Minimum 3 relay controlled page inputs
2. Minimum 6 relay controlled page outputs for each input
3. Minimum 16 supervised input lines
4. Include field connections for: Screw terminals, 25 pin DB connector, and USB.

2.07 QUICK CONNECT BOARDS

A. Quick Connect Boards are designed with a female DB connector to connect a cable from the station control card ports to screw clamp terminals that terminate the field wiring.
1. QCB-120-1 connects the audio port of either the SCC-300 or SCC-400/401 station control card to the field wiring.
2. QCB-120-2 connects the switch ports of an SCC-300 station control card to the field wiring.
3. QCB-120-5 is a 16-channel QCB that interfaces the output from a SCC-300 station control card to 45 ohm speakers.
4. QCB-120-6 is a 16 channel QCB, used in conjunction with up to four quick connect adapters QCA-120, converts the audio output from a SCC-300 or SCC-400/401 station control card to a line-level output or converts a line-level input to a audio levels compatible with SCC-300 or SCC-400/401 station control cards. Individual channels can be set to act as line-level inputs or line-level outputs.

2.08 DISCRETE I/O MODULES

A. Controller module shall provide 18 open drain outputs and 18 discrete inputs that can be software configured for either supervised or non-supervised operation.
   1. Control and monitoring of the discrete inputs and outputs provided through an Ethernet connection.
   2. Expander units provide 24 open drain outputs and 24 discrete inputs that can be software configured for either supervised or non-supervised operation.
   3. Up to three expander units can be daisy chained to a controller module.

B. DIO modules to be rack or wall mounted.

2.09 ADMINISTRATION AND CONTROL COMPUTER

A. The Service, Administration and Control computer shall provide the processing for the system's operation, configuration functions, and maintenance functions.

B. Interface to the DCC and DCE and appropriate components, master stations, and remote intelligent devices shall use Ethernet port connections.

C. Interface to the PLC control systems shall be an industry standard Ethernet addressable connections.

D. The Administration and Control computer shall meet the requirements of the workstation computers specified in Section 28 1000 with the addition of the following:
   1. Real Time Operating System.
   2. Communications system software.
   3. PCLTA cards with:
      a. LonWorks direct connect ports as required, or
      b. LonWorks free topology ports as required; or
      c. Ethernet IP ports.

2.10 ADMINISTRATOR SOFTWARE

A. Administrator Software to function on a standard PC to support system configuration, diagnostics, maintenance, and logging but not be required for system operation.

B. Administrator Software to employ Windows features including views of system tree structure, tables of devices, screens for system settings and adjustments, and tables of operational data.

C. Configuration features to include:
   1. Creation of overall system architecture.
   2. Creation of multiple device templates.
   3. Copy and paste functions with auto-numbering and auto-assignment to create device schedules.
   4. Configuration error detection and alerts.
   5. Device naming and call routing functions.
   6. Device setting and performance functions.

D. Diagnostic and Maintenance features to include:
   1. Verification of system configuration and installation.
   2. Verification of system networks.
   3. Verification of device connections.
   4. Verification of system operation.
   5. Diagnostics via modem or Ethernet ports.

E. Logging features to include:
   1. Display of system activity with filtering options.
   2. Search by time and date.
   3. Search by device.

4. Search by parameter.

2.11 INTERCOM STATION BOARDS

A. Intercom station boards are to be used to interface generic intercom stations and loudspeakers to system station audio boards for two-way voice communication or audio monitoring.

B. Units are to include microphone preamplifier, line supervision electronics, multiplexing electronics, and loudspeaker transformer.

C. Units are to include pigtail and switch options as required for each location.

2.12 DESKTOP HANDSET INTERCOM MASTER STATIONS

A. Desktop intercom master stations shall consist of display, keypads, internal speaker/microphone, and telephone handset with hookswitch.

B. Display module shall consist of 4-line by 20-character alphanumeric LCD display mounted behind a brushed stainless-steel face plate. Display shall include scratch and impact resistant window, adjustable viewing angle, and adjustable back lighting.

C. Function keys shall be provided below display to enter menu selections. Function key action shall be labeled on display and vary according to location in the menu structure or current options available.

D. Key switch lifetime for all keys, 10 million operations.

E. Internal intercom station audio interface shall consist of:
   1. Network and power supply interface, audio amplification and processing module, network and operating status LED's.
   2. Connectors and LED's shall be rear panel mounted.
   3. Internal loudspeaker/microphone assembly.
   4. External microphone interface with phantom power capability.
   5. External loudspeaker interface.
   6. Headset jack interface.
   7. External buzzer contact closure interface.
   8. Telephone handset and press-to-talk bar and hookswitch cradle shall be mounted on side of master station. Lifting handset from hookswitch shall automatically disconnect loudspeaker/microphone communications. Handset assembly shall incorporate standard coiled cord covered by armored flex.

F. Desktop intercom master station shall be as manufactured by Harding model IMS-640, or approved equal. The intercom master station shall be by the same manufacturer as the intercom system.

2.13 INTERCOM SUBSTATIONS

A. Intercom substations shall be tamperproof and weatherproof, maximum security grade, single button recessed intercom stations, designed for mounting on standard 2-gang or 3-gang outlet boxes. Contractor shall confirm size and provide accordingly. Faceplates shall be constructed of 11-gauge brushed stainless. Internal steel offset grille shall restrict inserting objects through speaker grille. Stations shall be ruggedly constructed and resistant to damage from soil and sprays.

B. Each intercom station shall incorporate an internal loudspeaker, microphone preamplifier and function multiplexing circuitry. One pushbutton shall be provided on each station. Pushbuttons shall be software assignable for placement of call requests.

C. Pushbuttons shall be single piece stainless steel construction and be back stopped to prevent excessive travel. Switch shall have positive tactile action with 1 million operation lifetime.

D. Loudspeakers shall be waterproof Mylar cone type.

E. All intercom station functions shall be transmitted over the existing 4-wire cable. Stations shall be provided with MTA type insulation displacement connector that requires no wire stripping for installation.

F. Outdoor intercom stations shall be identical in all respects to standard intercom stations except that all metal plates and hardware shall be stainless steel, and internal circuitry and components shall be conformally coated.

G. Each button shall be programmable, through the system, to call the master stations or to access any specific group function, e.g., group call, alarm call, etc. The labels and buttons shall be color coded, thorough fluorescent paint fill, within the engraved labeling and graphic identifiers.

H. Intercom stations shall be as manufactured by Harding ICE-420 series, or approved equal. The intercom substations shall be by the same manufacturer as the intercom system.

2.14 POWER SUPPLIES

A. Provide power supplies per manufacturer recommendations.

B. Input source to 100-120 VAC, 10 A maximum. Outputs shall be capable of providing up to 30 A at ± 12 Vdc. Voltage regulation ± 10%. Maximum ripple 1% peak to peak.

C. Units shall include independent dual supplies, front panel power switch and line power indicator, and independent supply status indicators. AC line input shall be fused and protection circuitry shall be provided for overload and over voltage conditions.

D. Power supplies shall incorporate rear mounted fan and filter assembly and ventilation slots in the front and side panels.

2.15 NETWORK REPEATERS

A. Network repeaters, if required, shall extend network cable limits or increase node limits. Each unit shall include network ports required. Data received on any port shall be re-transmitted on the other ports.

B. Units shall be surface wall mounted and include depluggable screw terminal connectors, redundant power supply connections and internal fuse to protect circuitry.

C. LED’s shall indicate receiving port, network activity, and power supply status.

2.16 PAGING AMPLIFIERS

A. Provide new commercial paging amplifiers which meet or exceed the operational characteristics listed below.

B. Provide Class 2 audio distribution for all existing paging speakers and horns.

C. Provide speaker matching transformers and level control transformers with less than 1% distortion at rated power. Transformers shall be rated for full capacity of loudspeakers served.

D. Provide amplifier matching transformers with less than 1% distortion at rated output power. Transformers shall be rated for full capacity of amplifier served.

E. Provide minimum of 16 Watts of amplifier power for each horn speaker in power load calculations plus 20% spare capacity. Power amplification shall be such that equal SPL is attained at listening level.

F. Provide minimum of 16 Watts of amplifier for each interior loudspeaker plus 20% spare capacity. Power amplification shall be such that equal SPL is attained at listening level.

G. Provide paging speaker and paging horn taps as required to balance and optimize output of each speaker and horn for each location.

H. Paging Amplifiers shall be 19” rack mount type.

I. Paging Amplifiers shall be fully compatible with all existing paging speakers and paging horns to be reused.

J. Paging Amplifiers shall be fully compatible and fully able to be integrated with the Intercom and PLC Security Control systems.

K. Paging Amplifiers shall be Harding, Stentofon, TOA, Aiphone, Bogan, Dukane, Crown, or approved equal.

2.17 PAGING SPEAKERS

A. Provide all paging speakers as shown on Contract Drawings.

B. Loudspeakers shall be nominal 8” diameter dual cone type units.

C. Loudsperkers shall have 8 or 16 ohm impedence and include multi tap transformer for use in 25 volt and 70 volt constant voltage type distribution systems.

D. Provide Atlas Sound, Series VP60-R recessed baffles (or approved equal), speaker enclosures and speaker installation appurtenances as required for ceiling mount, flush/concealed installation of speakers in all finished areas.

E. Provide loudspeakers as manufactured by SoundTube CM EZII, Atlas Sound, TOA, or approved equal.

F. Provide stainless steel or aluminum baffles and backboxes for all speakers in non-ceiling corridor spaces. The speakers, baffles and backboxes for enclosed speakers shall be by SoundTube, Atlas Sound, TOA, or approved equal

2.18 WIRE AND CABLE

A. Factory manufactured field interface cables shall be provided, as required, for all:

B. CBL-MST-AA male DB-15 connector with 6 individually shielded twisted pairs for connecting to master station ports.

C. CBL-STN-AA-BC with male DB-37 connectors at both ends and with 16 individually shielded twisted pairs for connecting from station control card audio ports to QCB-120-1 Quick Connect Board, or a male DB-37 connector at one end with 16 individually shielded twisted pairs for connecting from station control card audio port to terminal blocks.

D. CBL-SWT-AA-BC male DB-25 connector at one end and male DB-37 connector at the other end for connecting from SCC- 300 station control card switch port to QCB-120-2 Quick Connect Board, or a male DB-25 connector for connecting from SCC- 300 station control card and 16 individually unshielded twisted pairs for connecting to a terminal block.

E. PLC I/O switched logic relays.

F. Field wiring shall conform to manufacturer’s recommendations.

2.19 INTERCOM CABLE

A. Provide 22 AWG solid wire, twisted shielded pair for substations. Provide multiple trunk cables, as required. Control station and substation cabling shall be isolated from power and data transmission cabling. The cabling for paging speaker/horn zones shall be minimum 16 AWG stranded.

PART 3 EXECUTION

3.01 ZONING AND FINAL PROGRAMMING

A. Installation shall conform to all applicable codes and standards and the requirements of the manufacturer. All intercom sub-stations shall be flush mounted at each location shown on the Contract Drawings.

B. The Contractor shall provide system programming to enable system functions as described. Coordinate specific program requirements with the Owner.

C. Programming shall be redone as many times as required until full approval by the Owner is given.

D. Provide level control adjustments from panel mounted 'L' pads for each individual zone or speaker as required for adjustment by Owner personnel. Identify each level control with permanent markings in accordance with Contract Documents.

3.02 VERIFICATION OF OPERATION

A. Contractor shall verify all intercom, paging, signaling and programming capabilities described herein. The following capabilities shall be verified:
   1. System programming capability from the Master Station.
   2. All call functions, as required.
   3. Group call functions, as required.
   4. Alarm call functions, as required.
   5. Auto callback functions.
   6. Conference call functions, as required.
   7. Restricted access capability.
   8. Proper function and programming of substations.
   9. Proper function of system programming.
   10. Proper system programming as directed by DGS and Using Agency and Design Professional.
   11. No hum, buzz, or objectionable distortion in system.
   12. Fast, uniform, repeatable calls, call-ins, and registration of substations.
   13. Minimum 80 dBA at 10' for talkback function from pedestal.
   14. Minimum 75 dBA on all master stations from all substations at earpieces.
   15. Maximum PSIM integration response time of one (1) second, from any pedestal or substation notification in excluding Telco ring-down.
   16. Maximum intercom switching time for push-to-talk less than 330 milliseconds.
   17. System frequency response: 300 to 3,500 Hz.
   18. All system equipment to comply with the radiation limits for Class A digital devices of FCC Rules Part 15, Subpart B.
   19. Proper system programming as directed by the Owner and Design Professional.

3.03 TRAINING

A. Manufacturers shall be responsible for providing minimum training by authorized system installers/representatives to the Owner's personnel in compliance with Section 28 0500.

END OF SECTION

SECTION 28 7000
WATCH TOUR SYSTEM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

B. Refer to all Contract Drawings and specification sections listed in Section 280500 and 280510 for additional requirements.

C. Refer to Division 26 and 27 and the Electrical drawings for coordination requirements for power and infrastructure.

1.02 DESCRIPTION OF WORK

A. Provide all materials, labor, equipment, and services necessary for a complete Watch Tour System (WTS) as shown on the Contract Drawings and specified herein.

1.03 SYSTEM OPERATION

A. The Watch Tour System shall consist of solid state touch memory buttons mounted in stainless steel correctional grade housings. The memory buttons shall be mounted outside of the bedrooms in the housing units as outlined on the Contract Drawings.

B. The Watch Tour data collection device shall be a compact, heavy duty, powered by lithium batteries device that is used by the staff to record his/her tour by touching the touch memory buttons required for the specific tour. The data recording device shall be capable of storing over 4,800 reads.

C. The collection device shall download the tour data into a data transfer device that is Ethernet linked to the server. This transfer docking station located in the Master Control Room shall be capable of transferring data up to 10/100 Mb/sec.

D. The Watch Tour System shall consist of Guard Tour software, installed in the Control System server in the Main Equipment Room. The software shall consist of the data collection function, report generation and printing, extensive on-line support and training documentation, and support of GUI screen maps. Provide all software and licenses required.

E. The data collected shall be uploaded to the Control System server automatically after every tour. Custom reports shall be generated to meet the requirements of the Owner. Coordinate with the Owner to ensure reports and custom features are programmed properly.

1.04 REFERENCE STANDARDS AND CODES

A. National Electrical Code (NEC)

B. Underwriters Laboratory (UL)

C. Refer to applicable codes and standards listed in Section 28 05 00.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the “PERFORMANCE,” “OPERATIONS” and “RELIABILITY” requirements specified, provide a system manufactured by:

B. Shall be manufactured by Timekeeping Systems, Incorporated – Guard 1 Plus System, or approved equal.

2.02 TOUCH MEMORY DEVICES

A. Provide touch memory devices as shown on Contract Drawings.

B. The touch memory devices shall meet or exceed the following requirements:

1. Each button shall contain a microchip that will be programmed with a unique ID including cell or room number. Coordinate with Owner for ID information and incident code requirements.
2. The button shall be hermetically sealed, corrosion resistant, #304 stainless steel alloy.
3. Operate without supplementary power in a -4 to 40°C environment.
4. Mount each button in a stainless steel, tamper resistant, corrections proof, wall mount. All mounting hardware shall be torx-type, tamperproof hardware.

C. Hardened Button Base shall be model MM-34A1000-001.

2.03 DATA COLLECTOR WAND

A. The wand shall be made of corrosion resistant, #304 stainless steel alloy, totally waterproof and tamper resistant.
1. All electronics shall be embedded in epoxy resin.
2. The device shall be powered by lithium batteries with a minimum one (1) year warranty encased in a rubber sleeve. All battery connections shall be welded. Battery life shall be at least 2,500,000 reads.
3. The wand shall download data at a minimum of 115,200 baud.
4. The wand shall store a minimum of 4,800 unique identification points.
5. The wand shall be warranted for three (3) years.
6. Provide one (1) nylon holster for each wand provided.
7. Provide a total of 6 wands for the new facility.
8. Data Collector wand shall be Model PIPE-11-TKS by Timekeeping Systems, Inc.

B. ip download station/reader
1. The download station shall be ruggedly constructed to resist tampering with a weighted base to prevent tip over.
2. It shall support data transfer rates of up to 10/100 Mbsec.
3. It shall be compatible with the server operating system software and Watch Tour System software.
4. It shall have a pushbutton power check of the wand's battery.
5. It shall operate in a -4 to 40°C environment.
6. Operating voltage – 9VDC.
7. IP Download Station/ Reader shall be Model DL - IP by Timekeeping Systems, Inc.

2.04 WATCH TOUR SOFTWARE

A. Watch Tour software shall be installed on the Watch Tour Server and on workstations located in the Super Office, the Assistant Super Office, and the Shift Commander Office.

B. The Watch Tour software install in the Control server computer shall support the following features, or meet or exceed the following requirements:
1. True 24-hour a day unattended downloading.
a. Automatic detection of readers.
b. Remote downloading.
c. Generation of professional reports using MS Word.
d. Utilize flexible, powerful rules based reporting.
e. Exceptions reports identifying missed locations.
f. Custom reports and batch reports.
g. Support for pictures and maps for identifying locations of tour devices or checkpoints.
h. Supports creation of a group of locations requiring special review – supervisor patrols, separate weekend/holiday patrols.
i. Support rules or filters that allow the Owner to specify the number of visits to a group of locations during a specific time period.

j. Data maintenance – allowing data backup on regular schedule to a CD-ROM or network device.
k. Software shall utilize Microsoft SQL server database.
l. Contractor shall assist the Owner in developing reports that meet the facility's needs.
m. Software shall be Guard One Plus Server Edition, by Timekeeping Systems, Inc.

2.05 WATCH TOUR SERVER

A. Server shall be a state-of the-art server grade computer running Windows Server 2012 R2 operating system. Server shall be fully equipped to operate Guard 1 Plus Server Edition software.

B. Server shall be rack mountable, using an Intel Xeon Quad-Core Processor at 2.8 GHz or greater. It shall have minimum 4 GB of RAM, Gigabit Ethernet adapter, 80 GB hard drive or greater, and CD/DVD-R/RW Drive.

C. Server shall have SQL Server Reporting Services

D. Server shall be mounted in an industry standard 19-in. (483 mm) rack.

E. Server shall be as manufactured by Dell, HP, IBM, or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Contractor shall install watch tour system components at locations as shown on the Drawings.

B. Provide systems integration as required to implement all performance and operational requirements specified. Refer to Section 28 05 30.

C. Before installation Contractor shall verify exact location on single sample door with transition staff before mounting tape spot at each location for final mount approval.

3.02 COMPLETION

A. Testing
1. Contractor shall inspect and test the installation and operation of the system completely prior to acceptance tests. Refer to Sections 28 05 00, 28 05 10, and 28 05 30 for additional requirements.
2. Acceptance tests shall be conducted in conjunction with the Owner or Owner's Representative to ensure compliance with plans and specifications.

END OF SECTION

SECTION 31 0000
EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

B. Excavation for this Project shall be considered unclassified and shall include all types of earth and soil, any pebbles, boulders, and bedrock, municipal trash, rubbish and garbage and all types of debris of the construction industry such as wood, stone, concrete, plaster, brick, mortar, steel and iron shapes, pipe, wire, asphaltic materials, paper and glass. Unclassified excavation does not include unforeseen concrete foundations, walls, or slabs. All such materials encountered which are identified by this paragraph as unclassified shall be removed to the required widths and depths to create a finished product as shown and/or noted on the drawings and as written in the specifications. No additional compensation shall be made to the contractor for this unclassified excavation. The materials defined by this paragraph as unclassified will not be considered to be concealed conditions or unknown physical conditions below the surface of the ground for purposes of interpreting the language in the General Conditions of the Construction Contract.

C. Any available data concerning subsurface materials or conditions based on soundings, test pits or test borings, has been obtained by the County for its own use in designing this Project. The Test Boring location drawings and the Test Boring Logs, as well as the laboratory Test Results, contained within the Geotechnical Report are incorporated into the construction contract as a Contract Document. The remainder of the Geotechnical Report, with all other exhibits, is available for informational/guidance purposes only; it is not to be relied on by prospective bidders. The Report is available to Bidders but the Bidders must agree and acknowledge that the information and recommendations in the Report are not warranted for accuracy, correctness or completeness, and is not incorporated into the construction contract as a Contract Document.

D. Test Boring logs reflect the conditions at the specific locations of each Test Boring only. The Contractor accepts full responsibility for any conclusions drawn with respect to conditions between test borings. Bidders may perform their own investigation of existing subsurface conditions, with the County's approval. Excavation for the Project is considered "unclassified", as fully described in the Earthwork Section.

1.2 SUMMARY

A. Provide labor, materials, equipment and services, and perform operations required for Earthwork and related work as indicated on the drawings and specified herein.

B. Work Included: The work shall include, but not be limited to, the following:

1. Removal and disposal of existing pavements, curbs, utilities, footings, and unclassified and uncharted material required to be removed unless otherwise specified herein.

2. Excavation for utilities trenches, footings, pits, pile caps, grade beams, foundation walls, slabs, sidewalks and curbs.

3. Backfilling and filling for utilities trenches, footings, pits, slabs, sidewalks and curbs.

4. Furnishing, delivery and placement of new fill from an off site source.

5. Underpinning.

6. Sheet piling, sheeting and reshoring.

7. Protection.

8. Compaction.

9. Dewatering.

10. Rough Grading.

C. Related Sections:
Section 31 01 00 – Treatment of Pyrite Materials
Section 31 05 13 - Soils for Earthwork.
Section 31 05 16 - Aggregates for Earthwork.
Section 31 10 00 - Site Clearing.
Section 31 23 23 - Fill.
Section 31 25 00 – Erosion Control

1.3 QUALITY ASSURANCE

A. Codes, Regulations and Other Requirements: Comply with applicable codes, regulations and ordinances of authorities having jurisdiction over the work of this section. Whenever conflict arises, consult the Professional as to which requirements shall prevail.

B. Testing and Inspection Service

1. Contractor to engage the services of a testing laboratory to perform soil testing and inspection service for quality control during site grading operations. Furnish survey showing locations of soil samples to be taken and soil samples.

2. Test reports must be signed by a licensed Professional.

3. Tests for Proposed Soil Materials

a. Test soil materials proposed for use in the work and promptly submit test result reports.

b. Provide one optimum moisture content maximum density curve for each type of soil encountered in subgrade and fills. Determine maximum densities in accordance with ASTM D1557.

c. Moisture-Density Relations of Soils: Determine required reference "maximum densities" in accordance with ASTM D1557 as hereabove specified.

d. Determine sieve analysis of porous fill in accordance with Grain-Size Analysis of Soils ASTM D422.

e. The testing service will determine the suitability of materials to be used as fill.

f. For borrow materials, perform a mechanical analysis (AASHTO-T88), plasticity index (AASHTO-T91), moisture-density curve (AASHTO T180 or ASTM D1557), and frost susceptibility analysis.

g. Test for total sulfur analysis ASTM 4239 when carbonaceous material is expected.

1.4 REFERENCE STANDARDS:

A. Local utility standards when working within 24 inches of utility lines.

B. PennDOT Publication 408, current edition.

C. PADEP Erosion and Sediment Pollution Control Program Manual, dated March 2012 and all corrections.

D. Geotechnical Exploration Report prepared by Maser Consulting, dated August 26, 2020.

1.5 SUBMITTALS

A. Test Reports: Submit 2 copies of the following reports directly to the Professional and to others as required. All test results are to be submitted through the MATES process in E Builder.

1. Test reports on borrow material.

2. Field density test reports.

3. One optimum moisture content maximum density curve for each type of soil encountered.

4. Other tests and materials certificates as required.

1.6 PROJECT CONDITIONS

A. Examination of Site

1. Visit the site and carefully examine work of this section to become familiar with existing conditions and nature and scope of work and difficulties that attend its execution.

2. In addition, examine work that is intended to remain as part of the completed project and report unsatisfactory conditions to the County's Geotechnical Professional prior to commencement of work.

B. Subsurface Exploration Data

1. A geotechnical investigation report has been prepared by Maser Consulting and dated August 26, 2020..

2. The data on indicated subsurface conditions are not intended as representations or warranties of the accuracy or continuity between soil borings. It is expressly understood that the County, and Professional will not be responsible for interpretations or conclusions drawn therefrom by the Contractor. The data are made available for the convenience of the Contractor.

3. Additional test borings and other exploratory operations may be made at no cost to the County.

C. Permits: Apply for, obtain and pay for permits required by agencies and authorities having jurisdiction over the job site and over the site where excess and waste materials are to be dumped. Submit to County and Professional copies of permits and approvals.

D. Dust Control

1. Use all means necessary to control dust on or near the work.

2. Thoroughly moisten all surfaces as required to prevent dust being a nuisance to the public, neighbors, and performance of other work on the site.

E. Protection

1. Provide and erect temporary planking, bridges, fences, bracing, shoring, sheet piling, lights and warning signs required by jurisdictional authorities and site conditions to protect persons, streets, onsite and offsite property, as required and as supplementary to such items that have been left in place. Ascertain legal and other requirements.
2. Maintain protection until work has been completed and danger of damage has passed. When approved by County and Professional, remove protections.

F. Existing Utilities

1. Notify utility and telephone service companies before start of work.

2. Make arrangements with the utility companies for capping of their pipes and wiring. Ascertain that water systems, gas, sewers, electric services, etc., have been disconnected and capped before start of work.

3. Should uncharted, or incorrectly charted, piping, wiring or other utilities be encountered during excavation, consult the Geotech Quality Assurance Agent immediately for directions. Cooperate with County and utility companies in keeping respective services and facilities in operation.

4. Protect existing services indicated to remain. Replace and/or repair services damaged as a result of the work, to the satisfaction of the Geotech Quality Assurance Agent at no expense to the County.

G. Streets, Curbs and Sidewalks

1. Protect the streets, roads, curbs, sidewalks, and other existing items not to be removed. Portions damaged as a result of the work shall be replaced and repaired in compliance with the regulations of authorities having jurisdiction and without cost to County.

2. Do not close or obstruct street or sidewalks in connection with the work. Material or debris shall not be placed or stored in or on streets or sidewalks. Conduct operations so as to interfere as little as possible with normal activities.

3. Investigate the conditions of public thoroughfares and roads as to availability, clearances, load limits, restrictions and other limitations affecting transportation to and from the site and secure, in advance, such permits as may be necessary.

H. Explosives

1. The use of explosives is not permitted.

PART 2 - PRODUCTS

2. 1 MATERIALS

A. Soil Definitions

1. Satisfactory Soil Materials: Satisfactory soil materials are defined as those complying with the American Association of State Highway and Transportation Officials (AASHTO) Designation M145, soil classification Groups A-1, A-2-4, A-2-5, A-2-6 and A-3, A-4, A-5, and A-6.

2. Unsatisfactory Soil Materials: Unsatisfactory soil materials are defined as those described in AASHTO M145 for soil classification Groups A-2-7 and A-7; also, Pyritec Materials, peat and other highly organic soils; unless otherwise acceptable to the Professional.

3. Cohesionless Soil Materials: Cohesionless soil materials include gravel, sand-gravel mixtures, sands and gravelly-sands.

4. Cohesive Soil Materials: Cohesive soil materials include clayey and silty gravel, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, and sand-silt mixtures, clays, silts, and very fine sands.

B. Soil Materials

1. Backfill and Fill Materials

a. Satisfactory soil materials for backfill and fill shall be free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, Pyrite, vegetable and other deleterious matter.

b. Use excavated or borrow material that has been sampled, tested and certified as satisfactory soil material.

2. Lean Concrete

a. Where indicated on plan, lean concrete may be used as backfill below new footings. Lean concrete shall have a minimum compressive strength of 2,000 psi at 28 days.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.2 FINISH ELEVATIONS AND LINES

A. For setting and establishing layout of building and finish elevations and lines, secure the services of a registered civil engineer or a licensed land surveyor acceptable to the Professional. Carefully preserve all data and all monuments set by the civil engineer or surveyor and, if displaced or lost, immediately replace at no additional cost to the County.

3.3 EXCAVATION

A. Excavate the site as indicated on the drawing and as required for work of this section and work of other trades. Remove and dispose of material not suitable for reuse.

B. Excavation shall be unclassified and include the removal of materials visible on the ground surface and below grade to the dimensions and elevations indicated on the drawing or

required. Excavation shall include shale, rock, stone, underground structures, utilities and other materials which may be encountered.

1. Excavations for bottoms for piers, and footings shall be level, clean and clear of loose material and sections shall be true to size.

2. Except in locations where sheeting may act as formwork excavation shall extend 2 feet from indicated concrete work to permit placing and removal of forms.

3. Excavation for Pavements: Cut the surface under pavements to comply with cross-sections, elevations and grades as shown.

4. Excavation for Trenches

    a. Excavate trenches for pipes to a depth approximately 3 inches above invert elevations in earth and 8 inches below invert elevations in rock and add broken stone or gravel fill to bring bottom of trench to required elevation. Trench width shall be 2 feet wider than outside diameter of pipe of conduit. Where two or more pipes are to be laid in same trench, carry machine excavation only to depth required for highest pipe and hand excavate for lower pipes so not to disturb bearing for higher pipes. For conduit, excavate to underside of concrete duct bank.

    b. Bottom trimming of trenches is the work of other trades and is described in other Specification Sections.

    c. Coordinate trenching, pipe and conduit laying, and backfilling operations to keep open trenching to minimum.

C. Additional Excavation

1. When excavation has reached required subgrade elevations, notify the County's geotechnical Professional who will make an inspection of conditions.

2. If the County's geotechnical Professional deems the subgrade to be composed of unsuitable material the County's geotechnical Professional shall direct excavations made deeper and replace the excavated materials with suitable fill.

D. Material Storage

1. Stockpile excavated materials classified as satisfactory soil materials where directed, until required for fill. Place, grade, and shape stockpiles for proper drainage.

2. Legally dispose of excess unsatisfactory soil material, trash, debris, as specified herein.

F. Underpinning

1. Provide necessary underpinning, shoring and bracing of existing walls and structures, including vaults, utilities, etc. as required for the proposed subsurface work and to maintain stability of the existing structures.

    a. Extend underpinning to proper depth in relation to the subgrade levels, building construction and adjacent structures, to satisfactory earth bearing as approved by the County's geotechnical Professional.

    b. Underpinning shall be done with stone concrete mix and as approved by the Professional.

    c. Include underpinning of retaining walls and other existing elements for construction wherever necessary whether or not indicated. Notify adjoining property owners prior to work.

    d. Work in connection with underpinning shall be performed in strict conformance with the requirements of the applicable rules and regulations of agencies and authorities having jurisdiction.

G. Sheet Piling, Sheeting, Shoring and Reshoring

1. Tongued and grooved sheet piling shall be used where and as necessary to properly protect adjoining property and adjacent structures, to facilitate the work and to provide rock/soil retention, as needed.

    a. Sheet piling shall be kept back clear of new wall lines as directed by the Professional.

    b. Braces and timbers of sheet piling, shores and needles, are to be so placed that they shall not interfere with locations of and erection of columns, piers, buttresses, beams, etc., as needed to bear the loads.

    c. Tongued and grooved sheeting shall be of Southern Yellow Pine or Douglas Fir of thickness and size as needed to bear the loads.

    d. Sheet piling shall become the County's property and shall be left in place on the site, unless otherwise directed. All work to remain shall be of material that will not deteriorate over time.

2. Submit shop drawings of sheet piling, sheeting, soldier beams, walers, rakers, braces, laggings, etc., to the Professional for approval.

H. Protection: Furnish, maintain and protect each day and night including Saturdays, Sundays, holidays and during bad weather, lights, danger signals, barricades, planking, and clear, smooth unobstructed sidewalks until work under this Contract is completed.

I. When Pyrite is encountered, treat for Pyritic material in accordance with Section 31 01 00.

3.4 FILLING, BACKFILLING AND COMPACTION

A. Filling and Backfilling

1. Filling and backfilling shall consist of depositing, spreading and compacting approved materials to required elevations indicated. Approved materials for filling and backfilling, shall consist of suitable earth materials free from debris, organic substances, stumps, frozen materials, large boulders or other undesirable material.

B. Ground Surface Preparation

1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or breakup sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

2. When the existing ground surface has a density less than that specified under "Compaction" for the particular area classification, breakup the ground surface, pulverize, moisture-condition to the optimum moisture content, and compact to the required depth and percentage of maximum density.

C. Placement and Compaction

1. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches loose depth for material compacted by hand-operated compaction equipment.

2. Before compaction moisten or aerate each layer as necessary to provide the optimum moisture content of the soil material. Compact each layer to the required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

3. Backfill excavations as promptly as the work permits, but not until completion of inspection, testing, approval, and recording location of underground utilities, as required.

4. Compact fill and backfill to required density by approved mechanical means.

5. Keep area drained.

6. Place fill and backfill materials around buildings or other structures in layers not exceeding 8 inches thickness. Machine tamp each layer in place to form a solid mass. Backfill materials may be moistened to secure maximum compacted densities specified herein.

7. Do not place backfill against full height of building walls below grade unless they are laterally supported at top and bottom by floor construction or are temporarily braced by shores and walls. Such floors shall have seven (7) day strength when used to transmit pressures to which they will be subjected.

8. Backfill between walls and sides of excavation to 6 inches below indicated finished grade.

9. No backfilling shall be done until walls and piers have attained full design strength, and in no case within two weeks after stripping of concrete forms and the approval of the Professional has been obtained.

10. Heavy equipment such as bulldozers, loaders, and rollers shall not operate within four feet of structures.

11. Backfilling Trenches

    a. After the installation of piping and other underground service lines by others and the partial backfilling of the trenches by the Installers, as specified in other Specification Sections, backfill the trenches to required elevation.

    b. Compact backfill to required density by approved mechanical means or by hand operated equipment.

D. Compaction

1. Control soil compaction during construction, providing the minimum percentage of density specified for each area classification.

2. Percentage of Maximum Density Requirements: Compact soil to not less than 95 percent of maximum dry density beneath building foundations and floor slabs and 92 percent of maximum dry density behind site walls and beneath exterior pavement in accordance with ASTM D1557.

3. Moisture Control

    a. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to the surface of subgrade, or layer of soil material, to prevent free water appearing on the surface during or subsequent to compaction operations.

    b. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

    c. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing, or pulverizing until the moisture content is reduced to a satisfactory value.

3.5 ROUGH GRADING

A. Rough grading is defined as establishment of subgrade at a specified depth below finished grade. For paved or slab on grade areas rough grade elevations shall be finished grade elevations less thickness of pavement or slabs, and thickness of subbase if required.

B. Perform rough grading at site within limits of grading as shown on drawings. Relationship of existing grade to finished grade is shown on drawings by existing and finished contours. Indicated existing grades have been established from survey made by licensed surveyor. No additional compensation will be allowed for additional grading required because of variations between actual and indicated contours.

C. Take precautions to prevent fill on steep slopes from rolling or slipping downhill.

3.6 FIELD QUALITY CONTROL

A. Approval of Bearing Strata

1. The Contractor shall furnish adequate advance notification to the County and the Professional of times when footing excavations or paving subgrades are to be completed, so that the Construction Stage Geotech Quality Assurance Agent, directed by the Professional, can verify that the bearing quality of the soil has been properly inspected and/or tested by the Contractor. Formwork and concreting shall follow only after approval by the Construction Stage Geotech Quality Assurance Agent.

2. Should the bearing at the levels indicated be found by the Professional and the County to be inadequate, they may order the excavation carried down to sound bearing. Such excavation shall be classed as additional work and payment be made on the basis of an agreed price according to the General Conditions. Should suitable bearing be found at a lesser depth than indicated, the Professional and the County may order the reduction of excavation specified or shown on the drawings, and the Contractor shall allow a credit for excavation thus omitted on the same basis.

3. Request inspection of excavation and controlled fill operations in accordance with applicable code.

B. Quality Control Testing

1. The Contractor shall perform all necessary Quality Control tests and procedures for the performance of the work, in accordance with Section 014000 and this section, to produce the end results specified. The Contractor's Quality Control Agent shall maintain clear and orderly records of such tests and procedures and

make them available for field review and approval of the Professional and the County. The Contractor's bid shall include the cost of all Quality Control Tests and inspections.

2. The Contractor shall submit its plan for Quality Control testing to the Professional and the County for review and comments. The Professional shall consult with its Quality Assurance Agent in arriving at its opinion.
3. Quality Control tests shall include tests on fill material, optimum moisture content and maximum density and field density tests of fill layers. The Quality Control Agent shall comment on the suitability of all subgrades, and the subgrades shall be acceptable to the Professional.
4. Handwritten copies of field test reports shall be provided by the Contractor. They shall be given to the Contractor and County within two (2) hours of completion, but in no event shall the technician leave the site without providing the Contractor and Geotech Quality Assurance Agent with a copy of the test results. This shall include density, % moisture, plan location, elevation, comments and any other relevant data. Comments shall include any conditions that might have an adverse effect on the operations, including weather, drainage, etc.
5. The Contractor shall request consultation with the Professional on any problems that arise during construction. Copies of the daily in-place soil density tests shall be uploaded to E-Builder to the Professional by the Contractor through the testing agency within twenty-four (24) hours of the time the tests are made.
6. The Contractor shall approve each subgrade and each fill layer before proceeding to the next layer. Any area which does not meet density, % moisture or other requirements at any time, shall be suitably reworked and retested by the Contractor at his own expense.
7. The Professional and/or County will perform all Quality Assurance Testing and Inspection Services deemed necessary for the assurance of the Professional and/or the County. This does not relieve the Contractor of his responsibilities. The County will bear the cost of Quality Assurance tests and inspections.

C. Compaction standards are to be based on Modified Proctor standards, as defined by ASTM D1557.

3.7 MAINTENANCE

A. Protection of Graded Areas

1. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

2. Repair and re-establish grades in settled, eroded, and rutted areas to the specified tolerances.

B. Reconditioning Compacted Areas: Where compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape, and compact to the required density prior to further construction.

C. Stockpiling and Disposal of Excess and Waste Materials

1. Topsoil, construction materials, and waste materials may be stockpiled as shown on the Drawings for re-use on the site to the extent that sufficient area exists within the limits of disturbance for this purpose. The Contractor is responsible for locating an off-site area for stockpiling materials.

2. Stockpile locations shall be relocated to account for the multiple stages of construction as determined by the Professional.

2. Removal from County's Property

a. Remove waste materials, including excavated material classified as unsatisfactory soil material, trash and debris, and dispose of it off the County's property.

b. Remove excess excavated material, trash, debris and waste materials, and dispose of it off the County's property.

END OF SECTION

SECTION 31 0100
TREATMENT OF PYRITIC (SULFIDE) MATERIALS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. This work is the treatment of potentially expansive pyritic materials (% pyritic sulfur content >0.10) located directly under the floor slab and foundations in building areas and future housing unit areas with the application of bituminous materials and, if required, blotter materials. Refer to Sulfide Induced Heave Mitigation, Section 7.2 and the Exploration Location Plan, Figure 2 of Maser Consulting's geotechnical report dated August 26, 2020.

1.3 UNIT PRICE – MEASUREMENT AND PAYMENT

A. Expansive pyritic material over-excavation and removal from site: 1,500 CY

B. PennDOT 2A Stone (or approved RCA) – Import and Backfill: 1,500 CY

C. Bituminous Coating (2 applications): 2,400 SY

PART 2 – PRODUCTS

2.1 BITUMINOUS MATERIAL

A. One of the following, as specified in PENNDOT Publication 408/2003, Section 702:

Class of Material	Type of Material	Application Temperature (°F) Minimum	Maximum
MC-30	Cut-back Petroleum Asphalt	70	100
MC-70	Cut-back Petroleum Asphalt	100	150

B. If, due to time of year, the above materials are not available, then the following alternative materials can be used:

1. HYDROCIDE 600 asphalt emulsion, as manufactured by Sonneborn Building Products of Minneapolis, Minnesota.

2. HYDROCIDE 700B SEMI-MASTIC asphalt emulsion, as manufactured by Sonneborn Building Products of Minneapolis, Minnesota.

2.2 BLOTTER MATERIALS

A. Fine Aggregate – Mortar sand - PENNDOT Publication 408/2003, Section 703.1.

PART 3 – EXECUTION

3.1 CONSTRUCTION

A. Perform supplemental percent pyritic sulfur testing within the building footprint to further evaluate and delineate the potential areas and their extents to be remediated. Supplemental testing shall be performed by the Owner's Geotech Quality Assurance Agent.

B. Undercut the pyritic material to 3 feet below the bottom of foundation and 5 feet below floor slab subgrade. Extend over-excavations 2 feet laterally beyond the foundation extents. Over-excavations are not required within the future housing unit area. Refer to Figure 2 of the project Geotechnical Report, by Maser Consulting, dated August 26, 2020 for the anticipated treatment area ("proposed sulfide induced heave mitigation area"). As soon as practical, treat the exposed surfaces (horizontal and vertical) of the excavation as well as the exposed subgrade within the future housing unit area with sprayed bitumen as follows:

1. Apply an initial layer of cut-back petroleum asphalt MC-30, distributed at a rate of 0.20 to 0.50 gallon per square yard, at an application temperature of between 70 and 120°F.

2. Allow the initial layer to cure completely (minimum time = 24 hours, possibly as great as 48 hours or longer, depending on ambient air temperature and weather).

3. Apply a final layer of cut-back petroleum asphalt MC-70, distributed at a rate of 0.20 to 0.50 gallon per square yard, at an application temperature of between 100 and 150°F.

4. Allow the final layer to cure completely (minimum curing time similar to that for MC-30).

5. If necessary, a fine aggregate "blotter" material (mortar sand) can be used to reduce curing time; however, the minimum curing time should not be less than 24 hours for either application.

C. If HYDROCIDE products are used, follow the manufacturer's recommended application procedures for "exterior surfaces below grade – porous surfaces".

C. For excavations located within potentially expansive pyritic materials, apply the same bitumen treatment to the vertical trench walls as described above.

E. After curing, backfill the overexcavation with PennDOT 2A stone or recycled concrete aggregate conforming to a similar gradation. Place the backfill material directly on the treated surfaces.

F. If applicable, immediately prior to applying sprayed bitumen treatments or to placing concrete, thoroughly proof-roll the bottom of the excavations with heavy equipment until no movement is observed or as directed by the Geotech Quality Assurance Agent as directed by the Professional. Remove and replace any soft materials delineated by this process with imported PennDOT 2A stone as directed by the Geotech Quality Assurance Agent.

END OF SECTION

SECTION 31 0513
SOILS FOR EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:
1. Subsoil materials.
2. Topsoil materials.

B. Related Sections:
1. Section 31 00 00 - Earthwork
2. Section 31 05 16 – Aggregates for Earthwork.
3. Section 31 22 13 – Rough Grading.
4. Section 31 23 16.13 – Trenching.
5. Section 31 23 23 – Fill.
6. Section 31 25 00 – Erosion Controls.
7. Section 32 91 19 – Landscape Grading.
8. Section 32 92 19 – Seeding.
9. Section 32 93 00 – Plants.

1.3 UNIT PRICES - MEASUREMENT AND PAYMENT- NOT USED

1.4 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:
1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

C. PennDOT Publication 408, current edition.

D. PADEP Erosion and Sediment Pollution Control Program Manual, dated March 2012 and all corrections.

E. Geotechnical Exploration Report prepared by Maser Consulting, dated August 26, 2020.

1.5 SUBMITTALS

A. Materials Source: Submit name of imported materials source and provide a “clean fill” certification. No material shall be brought on-site of unknown origin.

B. Manufacturer's Certificate: Certify Structural Fill meets or exceeds gradation envelope.

C. Compost Mix: If pre-mixed amended soil is used, submittals stating the mix ratio must be provided. Submit testing report to certify compost meets PA DEP standards as shown on the drawings.

1.6 QUALITY ASSURANCE

A. Furnish each subsoil and topsoil material from single source throughout the Work.

B. Perform Work in accordance with PennDOT Publication 408, current edition.

C. Perform Work in accordance with the PA DEP BMP Manual, current edition.

PART 2 - PRODUCTS

2.1 SUBSOIL MATERIALS

A. General Fill shall conform with PennDOT Publication 408, Section 206 – Embankment.

B. General Fill Material shall be of a maximum size that can readily be placed in loose 8-inch layers.
   1. Gradation – More than 35% passing No. 200 sieve.
   2. Minimum dry mass density – 95 lbs per cubic feet determined according to PTM No. 106, Method B.
   3. Maximum liquid limit -65, determined according to AASHTO 89.
   4. Plasticity Index – Not less than liquid limit minus 30, determined according to AASHTO T90 for soils with liquid limits of 41 to 65.

2.2 STRUCTURAL FILL MATERIALS

A. Naturally or artificially graded soil meeting AASHTO A-2-4, A-2-6, A-4, A-6, or PennDOT 2A Coarse Aggregate.

B. Structural fill shall be compacted to at least 95 percent of the laboratory determined dry density (ASTM D1557).

C. Structural fill materials shall be well graded, inert, free of any degradable or deleterious material, and should not contain particles larger than 6” in maximum dimension. If the lift thickness is reduced, a corresponding reduction should be made in the maximum allowable particle dimension.

D. Structural fill shall be compacted to at least 95 percent of the laboratory determined dry density as determined by ASTM D1557.

2.3 TOPSOIL MATERIALS

A. Topsoil: Conforming to PennDOT Publication 408, Sections 801 and 802.

2.4 COMPOST MATERIALS

A. Compost: Conforming to PADEP Erosion and Sediment Pollution Control Program Manual, dated March 2012 and all corrections.

B. Compost Mix: If pre-mixed amended soil is used, the amended soil must consist of a 2:1 (Topsoil: Compost) ratio.

2.5 SOURCE QUALITY CONTROL

A. Testing and Analysis of Subsoil and Topsoil Material: Perform in accordance with AASHTO T180.

B. When tests indicate materials do not meet specified requirements, change material and retest.

C. Furnish materials of each type from same source throughout the Work.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavate subsoil and topsoil from areas designated. Strip topsoil to full depth and stockpile as shown on the Drawings for re-use on the site to the extent that sufficient area exists within the limits of disturbance for this purpose. The Contractor is responsible for locating an off-site area for stockpiling materials

B. Stockpile excavated material meeting requirements for subsoil materials and topsoil materials to the extent that sufficient area exists within the limits of disturbance for this purpose. The Contractor is responsible for locating an off-site area for stockpiling material.

C. Remove waste materials, including excavated material classified as unsatisfactory soil material, trash and debris, and dispose of it off the Department's property.

D. Remove excess excavated material, trash, debris and waste materials, and dispose of it off the Department's property.

E. Subsoil area beneath the compost shall be loosened to less than 200 psi to a depth of 20” below final topsoil grade. The contractor shall verify that the sub-soil work conforms to the specified depth.

3.2 STOCKPILING

A. Stockpile on-site in sufficient quantities to meet Project schedule stages and requirements to the extent that sufficient area exists within the limits of disturbance for this purpose. The Contractor is responsible for locating an off-site area for stockpiling excess materials.

B. Separate differing materials with dividers or stockpile apart to prevent mixing.

C. Prevent intermixing of soil types or contamination.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

E. Stockpile unsuitable materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 0516
AGGREGATES FOR EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:
   1. Coarse aggregate materials.
   2. Fine aggregate materials.
   3. Clean aggregate materials.

B. Related Sections:
   1. Section 31 05 13 – Soils for Earthwork.
   2. Section 31 05 19.13 – Geotextile for Earthwork.
   3. Section 31 22 13 – Rough Grading.
   4. Section 31 23 16.13 – Trenching.
   5. Section 31 23 19 – Dewatering.
   6. Section 31 23 23 – Fill.
   7. Section 31 25 00 – Erosion Controls.
   8. Section 32 11 23 – Aggregate Base Course.
   9. Section 32 12 16 – Asphalt Paving.
   10. Section 32 13 13 – Concrete Paving.
   11. Section 32 91 19 – Landscape Grading.
   12. Section 33 11 16 – Site Water Utility Distribution Piping.
   13. Section 33 31 00 – Sanitary Utility Sewerage Piping.
   14. Section 33 41 00 – Storm Utility Drainage Piping.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
   1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
   2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:
   1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).

3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
4. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

C. PennDOT Publication 408, current edition.

D. Geotechnical Exploration Report prepared by Maser Consulting, dated August 26, 2020.

1.5 SUBMITTALS

A. Materials Source: Submit name of imported materials suppliers.

B. Manufacturer's Certificate: Certify Products meet or exceed PennDOT Publication 408 standards.

1.6 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work in accordance with PennDOT Publication 408 standards.

PART 2 - PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Type C. Conforming to PennDOT Publication 408, Section 703.2.

2.2 CLEAN COARSE AGGREGATE MATERIALS

A. AASHTO #57 clean stone for use in underground detention facility, as shown and detailed on the Drawings.

B. AASHTO #3 clean stone for use as subbase under pervious pavers, as shown and detailed on the Drawings.

C. Conforming to PennDOT Publication 408, Section 703.2.

D. All material is to be clean-washed prior to installation.

2.3 FINE AGGREGATE MATERIALS

A. Conforming to PennDOT Publication 408, Section 703.1.

2.4 SOURCE QUALITY CONTROL

A. Coarse Aggregate Material (including Clean Aggregate Materials) - Testing and Analysis: Perform in accordance with ASTM D1557, AASHTO T180, ASTM D4318, ASTM C136, and PennDOT Bulletin 15.

B. Fine Aggregate Material - Testing and Analysis: Perform in accordance with ASTM D1557, AASHTO T180, ASTM D4318, ASTM C136, and PennDOT Bulletin 15.

C. When tests indicate materials do not meet specified requirements, change material and retest.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Remove excess excavated materials, coarse aggregate materials, and fine aggregate materials not intended for reuse from site.

B. Remove excavated materials not meeting requirements for coarse aggregate materials, and fine aggregate materials from site.

3.2 STOCKPILING

A. Stockpile in sufficient quantities to meet Project schedule and requirements to the extent that sufficient area exists within the limits of disturbance for this purpose. The Contractor is responsible for locating an off-site area for stockpiling materials

B. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

C. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 0519.13

GEOTEXTILES FOR EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Erosion Control Matting.
2. Nonwoven geotextile material.

B. Related Requirements:

1. Section 31 23 23 - Fill: Backfilling required at building perimeter and Site structures to subgrade elevations; fill under slabs on grade, pavement, and landscaped areas.
2. Section 31 25 00 - Erosion and Sedimentation Controls: Erosion and sedimentation control devices.
3. Section 32 11 23 - Aggregate Base Courses: Subbase and base course for placement under paving.
4. Section 32 91 19 - Landscape Grading: Placing, leveling, and compacting topsoil materials prior to final landscaping.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.

B. ASTM International:

1. ASTM D4355/D4355M - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
2. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
3. ASTM D4533/D4533M - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

4. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
5. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
6. ASTM D4833/D4833M - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
7. ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
8. ASTM D4884/D4844M - Standard Test Method for Strength of Sewn or Bonded Seams of Geotextiles.
9. ASTM D4886 - Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method).
10. ASTM D6525/D6525M - Standard Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products.
11. ASTM D6566 - Standard Test Method for Measuring Mass per Unit Area of Turf Reinforcement Mats.
12. ASTM D6567 - Standard Test Method for Measuring the Light Penetration of a Turf Reinforcement Mat (TRM).
13. ASTM D6818 - Standard Test Method for Ultimate Tensile Properties of Rolled Erosion Control Products.

C. PennDOT Publication 408, current edition.

D. PADEP Erosion and Sediment Pollution Control Program Manual, dated March 2012.

A. Geotechnical Exploration Report prepared by Maser Consulting dated August 26, 2020.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer information including tensile strength, elongation, thickness, UV resistance, and other material specifications.

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

C. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

D. Qualifications Statements:

1. Submit qualifications for manufacturer and installer.
2. Submit manufacturer's approval of installer.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of geotextile material, including placement depth. Provide photographs of geotextile in-place.

1.7 QUALITY ASSURANCE

A. Perform Work according to Drawings and Conservation District standards.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' experience and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Comply with ASTM D4873.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 EROSION CONTROL MATTING

A. Manufacturers: Furnish materials according to Drawings and Conservation District standards.

B. Description: Machine-produced mat of 100% agricultural straw covered with a light-weight, photo-degradable, polypropylene netting.

C. Performance and Design Criteria:

1. Comply with AASHTO M288.
2. Mass per Unit Area: Comply with ASTM D6566.
3. Thickness: Comply with ASTM D6525.
4. Light Penetration: Comply with ASTM D6567.
5. Tensile Strength (Grab): Comply with ASTM D4632.
6. Maximum Elongation: Comply with ASTM D6818.
7. Resiliency: Comply with ASTM D6524.
8. Average Flexibility: Comply with ASTM D6575.
9. Functional Longevity: Between 9 – 12 months.

2.2 NONWOVEN GEOTEXTILE MATERIALS

A. Manufacturers: Furnish materials according to Drawings and Conservation District standards.

B. Description:

1. Non-biodegradable, UV-resistant, nonwoven geotextile fabric.
2. Calendar such that yarns will retain relative positions.

C. Performance and Design Criteria: Comply with ASTM D4491.

1. Wide-Width Strip Tensile Strength: Comply with ASTM D4632/D4632M.
2. Elongation: Comply with ASTM D4632/D4632M.
3. Trapezoidal Tear Strength: Comply with ASTM D4533/D4533M.
4. Puncture Strength: Comply with ASTM D4833/D4833M.
5. UV Resistance at 500 Hours: Comply with ASTM D4355/D4355M.

2.3 ACCESSORIES

A. Securing Pins: Per Manufacturer Specifications

B. Wire Staples: Per Manufacturer Specifications

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that underlying surface is smooth and free of ruts or protrusions that could damage geotextile material.

3.2 PREPARATION

A. Subgrade Material and Compaction Requirements: Contact Project Professional for inspection and approval of subgrade 48 hours prior to installation of geotextile material.

3.3 INSTALLATION

A. Geotextile Material:

1. Lay and maintain smooth and free of tensile stresses, folds, wrinkles, or creases.
2. Ensure that material is in direct contact with subgrade.

B. Securement Pins:

1. Install per manufacturers requirements
2. Ensure that washer bears against geotextile.

C. Seams:

1. Install per manufacturers requirements

D. Penetrations: As indicated on Drawings

E. Repairing Damaged Geotextiles:

1. Repair torn or damaged geotextile by overlapping a new piece beyond edge of damaged area, and fasten as recommended by geotextile manufacturer.
2. Remove and replace geotextile rolls which cannot be repaired.

F. Fill and Cover:

1. Place fill to prevent tensile stress or wrinkles in geotextile.
2. Place fill from bottom of side-slopes upward.
3. Do not drop fill from height greater than 3 feet.

3.4 PROTECTION

A. Ballast: Adequate to prevent uplift of material by wind.

B. UV Exposure: Do not leave material uncovered for more than 14 days after installation.

C. Do not operate equipment directly on top of geotextile.

END OF SECTION

SECTION 31 1000
SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:
   1. Salvaging of specified items and delivering to the Department.
   2. Removing paving, curbs, and sidewalks as needed to complete work.
   3. Removing trees, shrubs, and other plant life as needed to complete work.
   4. Removing abandoned utilities and storm piping.
   5. Remove foundation bases and utility pads.
   6. Remove fencing.
   7. Remove retaining walls.
   8. Removal of all items identified and not identified on the site and architectural Drawings as needed to complete work.

B. Related Sections:
   1. Section 31 00 00 - Earthwork
   2. Section 31 22 13 – Rough Grading.
   3. Section 31 25 00 – Erosion Controls.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCE STANDARDS

A. PADEP Erosion and Sediment Pollution Control Program Manual, dated March 2012 and all corrections.

B. Geotechnical Exploration Report prepared by Maser Consulting dated August 26, 2020.

1.5 SUBMITTALS

A. Provide an OSHA compliant safety plan for the project prior to starting work. Maintain one (1) copy on-site. The safety plan shall address the specific safety / compliance concerns applicable to its activities in the field, shop, and office such as the following:

- Site Specific Safety Concerns and Standard Operating Procedures
- Personal Protective Equipment (PPE)
- HAZCOM/Right to Know
- Lockout/Tagout Knowledge and Training
- Illness/Injury Recordkeeping and Posting
- OSHA Poster Review

- Reporting Serious Accidents
- Training

B. Weekly safety meetings shall be conducted with all site employees and documentation including meeting minutes and sign-in sheets shall be submitted. These meetings shall deal with specific relevant safety issues as they relate to the work.

C. Provide a plan to implement measures to prevent the spreading of invasive plant and seeds with the following:
   1. Ensure vehicles and equipment entering and exiting the site are clean of invasive plants and seed.
   2. Limit the movement of weed-infested soil or gravel
   3. Use certified weed-free seed mixes or vegetation in disturbed areas to provide competition for any new weeds
   4. Treat new infestations quickly -work with local invasive plant groups to deal with new infestations.
   5. Contain neighboring infestations and restrict movement of invasive plants from adjacent lands. Roadways, railways and waterways are often corridors for invasive plant spread and should be monitored for invasive plant establishment.
   6. Protect areas that are not infested.

1.6 Use native plants and seed mixes for revegetationQUALITY ASSURANCE

A. All specifications shall conform to PennDOT Publication 408, current edition.

B. Perform Work in accordance with PA DEP regulations.

C. Perform Work in accordance with OSHA regulations.

D. Implement US Fish and Wildlife Nationwide Conservation Measures for migratory birds found at https://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures/nationwide-standard-conservation-measures.php

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing plant life, or items to be salvaged, designated to remain is tagged or identified.

B. Conduct a pre-construction site inspection with representatives of the Department to identify any items for salvaging and delivery to the Department.

3.2 PREPARATION

A. Contact Department not less than 3 working days before calling Local Utility Line Information Service and not less than 5 working days before performing Work.

B. Schedule a pre-construction meeting with the University Arborist to review the site clearing limits and tree removal.

C. Call Local Utility Line Information Service at 811 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

D. The Contractor shall file with the Federal Aviation Administration (FAA) in accordance with CFR Title 14 Part 77.9, at a minimum of 45 days in advance of construction.

3.3 PROTECTION

A. Locate, identify, and protect utilities indicated on the Drawings as to remain, from damage.

B. Protect trees, plant growth, and features designated on the Drawings and University Arborist to remain with construction fencing.

C. Protect bench marks, survey control points, and existing structures from damage or displacement.

3.4 CLEARING

A. Clear areas required for access to site and execution of Work.

B. Remove trees and shrubs within designated limits of disturbance and listed as to be removed.

3.5 REMOVAL

A. Remove existing foundations, drainage pipes, and structures not being utilized with the project, reset existing structures; removal of debris, rock, stone, and extracted plant life from site as depicted on plans. Remove fencing and retaining walls as indicated on the Drawings.

B. Remove paving, curbs, and sidewalks as indicated on Drawings. Neatly saw cut edges at right angle to surface.

C. Remove abandoned utilities, tower lights, and storm pipes as indicated on the Drawings. Indicated removal termination point for underground utilities on Record Documents. Coordinate work with utility companies.

D. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

E. Do not burn or bury materials on site. Leave site in clean condition.

3.6 TOPSOIL EXCAVATION

A. Excavate topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials for use in finish grading.

B. Do not excavate wet topsoil or material.

C. Stockpile in areas designated on site to the extent that sufficient area exists within the limits of disturbance for this purpose. The Contractor is responsible for locating an off-site area for stockpiling materials. Protect from erosion.

D. Remove excess topsoil not intended for reuse from site.

END OF SECTION

SECTION 31 2213

ROUGH GRADING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Excavating topsoil.
2. Excavating subsoil.
3. Cutting, grading, filling, rough contouring, and compacting site for structures, building pads, and utilities.

B. Related Sections:
1. Section 3100 00 - Earthwork
2. Section 31 05 13 - Soils for Earthwork: Soils for fill.
3. Section 31 05 16 - Aggregates for Earthwork: Aggregates for fill.
4. Section 31 10 00 - Site Clearing: Excavating topsoil.
5. Section 31 23 16 - Excavation: Building excavation.
6. Section 31 23 16.13 - Trenching: Trenching and backfilling for utilities.
7. Section 31 23 23 - Fill: General building area backfilling.
8. Section 32 91 19 - Landscape Grading: Finish grading with topsoil to contours.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).

3. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
4. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
5. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
6. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
7. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head).
8. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
9. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

C. PADEP Erosion and Sediment Pollution Control Program Manual, dated March 2012 and all corrections.

D. Geotechnical Exploration Report prepared by Maser Consulting, dated August 26, 2020.

1.5 SUBMITTALS

A. Materials Source: Submit name of imported materials suppliers.

B. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with ASTM C136, ASTM D2419, and ASTM D2434.

B. Perform Work in accordance with Conservation District standards.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Section 31 05 13 – Soils for Earthwork: Topsoil and subsoil fill.

B. Section 31 05 16 – Aggregates for Earthwork: Structural and General fill.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify site conditions for the Work are in accordance with the Drawings.

B. Verify survey bench mark and intended elevations for the Work are as indicated on Drawings.

3.2 PREPARATION

A. Contact Department not less than 5 working days before performing Work.

B. Call Local Utility Line Information service at 811 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

C. Identify required lines, levels, contours, and datum.

D. Protect utilities indicated to remain from damage.

E. Protect plant life, lawns, and other features remaining as portion of final landscaping.

F. Protect bench marks, survey control point, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.3 TOPSOIL AND SUBSOIL EXCAVATION

A. Section 31 05 13 – Soils for Earthwork: Use topsoil from areas to be further excavated, re-landscaped, or regraded without mixing with foreign materials for use in finish grading.

B. Section 31 23 16 – Excavation: Do not excavate wet topsoil.

C. Stability: Replace damaged or displaced subsoil as specified for fill.

3.4 FILLING

A. Fill areas to contours and elevations with unfrozen materials.

B. Place fill material in continuous layers and compact.

C. Maintain optimum moisture content of fill materials to attain required compaction density.

D. Slope grade away from building minimum 2 percent slope for minimum distance of 10 ft, unless noted otherwise on the Drawings.

E. Make grade changes gradual. Blend slope into level areas.

F. Repair or replace items indicated to remain damaged by excavation or filling.

3.5 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 0.10 feet from required elevation.

3.6 FIELD QUALITY CONTROL

A. Perform laboratory material tests in accordance with ASTM D1557, ASTM D698, or AASHTO T180.

B. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D1556, ASTM D2167, or ASTM D2922.
2. Moisture Tests: ASTM D3017.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

END OF SECTION

SECTION 31 2316
EXCAVATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:
   1. Excavating for Stormwater Facilities.
   2. Excavating for Foundations.
   3. Excavating for site structures.
   4. Excavating for utility, water, and sanitary facilities.
   5. Excavating for landscaping.

B. Related Sections:
   1. Section 31 00 00 – Earthwork
   2. Section 31 01 00 - Treatment of Pyritic Materials
   3. Section 31 05 13 – Soils for Earthwork.
   4. Section 31 05 16 – Aggregates for Earthwork.
   5. Section 31 22 13 – Rough Grading.
   6. Section 31 23 16.13 – Trenching.
   7. Section 31 23 19 – Dewatering.
   8. Section 31 23 23 – Fill.
   9. Section 33 05 16.13 – Precast Concrete Utility Structures.
   10. Section 33 05 17 – Precast Concrete Valve Vaults and Meter Boxes.
   11. Section 33 11 16 – Site Water Utility Distribution Piping.
   12. Section 33 31 00 – Sanitary Utility Sewerage Piping.
   13. Section 33 41 00 – Storm Utility Drainage Piping.
   14. Section 33 44 16 – Utility Trench Drains.
   15. Section 33 51 00 – Natural Gas Distribution.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCE STANDARDS

A. Local utility standards when working within 24 inches of utility lines.

B. PennDOT Publication 408, current edition.

C. PADEP Erosion and Sediment Pollution Control Program Manual, dated March 2012 and all corrections.

D. Geotechnical Exploration Report prepared by Maser Consulting, dated August 26, 2020.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with PennDOT Publication 408, current edition.

1.6 QUALIFICATIONS – NOT USED

PART 2 - PRODUCTS- NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

A. Contact County not less than 5 working days before performing Work.

B. Call Local Utility Line Information service at 811 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

C. Identify required lines, levels, contours, and datum.

D. Notify utility company to remove and relocate utilities.

E. Protect utilities indicated to remain from damage.

F. Protect plant life, lawns, rock outcroppings and other features remaining as portion of final landscaping.

G. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.2 EXCAVATION

A. Excavate subsoil to accommodate building foundations, slabs-on-grade, paving and site structures and construction operations to the required depth as shown on the plans, or as needed to complete the work.

B. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with Section 31 23 23 – Fill and Section 31 23 16.13 Trenching.

C. Slope banks with machine to angle of repose or less until shored.

D. Do not interfere with 45 degree bearing splay of foundations.

E. Grade top perimeter of excavation to prevent surface water from draining into excavation.

F. Trim excavation. Remove loose matter.

G. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd measured by volume. Remove larger material as specified in Section 31 23 23 – Fill.

H. Notify Professional of unexpected subsurface conditions.

I. Correct areas over excavated with structural fill as directed by Geotechnical Quality Assurance Agent as directed by the Professional.

J. Remove excess and unsuitable material from site.

K. Stockpile excavated material in area designated on site in accordance with Section 31 05 13 – Soils for Earthwork.

L. Repair or replace items indicated to remain damaged by excavation.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

3.4 PROTECTION

A. Prevent displacement or loose soil from falling into excavation; maintain soil stability.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

C. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION

SECTION 31 2316.13
TRENCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Compacted fill from top of utility bedding to subgrade elevations.
2. Backfilling and compaction.

B. Related Sections:

1. Section 03 30 00 – Cast-In-Place Concrete.
2. Section 26 56 00 – Exterior Lighting.
3. Section 31 00 00 - Earthwork
4. Section 31 05 13 – Soils for Earthwork.
5. Section 31 05 16 – Aggregates for Earthwork.
6. Section 31 22 13 – Rough Grading.
7. Section 31 23 16 – Excavation.
8. Section 31 23 19 – Dewatering.
9. Section 31 23 23 – Fill.
10. Section 32 91 19 – Landscape Grading.
11. Section 33 41 00 – Storm Utility Drainage Piping.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
3. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

4. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

C. PennDOT Publication 72M, RC Standards, current edition.

D. PennDOT Publication 213, current edition.

E. PennDOT Publication 408, current edition.

F. Local Utility Company Standards and Details.

G. Geotechnical Exploration Report prepared by Maser Consulting dated August 26, 2020.

1.5 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, or cable.

1.6 SUBMITTALS

A. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with PennDOT Publication 408, current edition.

1.8 QUALIFICATIONS

A. Prepare excavation protection plan under direct supervision of professional experienced in design of this Work and licensed in State of Pennsylvania.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 COORDINATION

A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. General Fill: As specified in Section 31 05 13 – Soils for Earthwork.

B. Structural Fill: As specified in Section 31 05 13 – Soils for Earthwork and Section 31 05 16 – Aggregates for Earthwork.

PART 3 - EXECUTION

3.1 LINES AND GRADES

A. Lay pipes to lines and grades indicated on Drawings.

1. Professional reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

B. Use laser-beam instrument with qualified operator to establish lines and grades.

3.2 PREPARATION

A. Contact County and Client Quality Assurance Agent Agency not less than 5 working days before performing Work.

B. Call Local Utility Line Information service at 811 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

C. Identify required lines, levels, contours, and datum locations.

D. Protect plant life, lawns, rock outcropping and other features remaining as portion of final landscaping.

E. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

F. Maintain and protect above and below grade utilities indicated to remain.

3.3 TRENCHING

A. Excavate subsoil required for utilities to utility service.

B. Remove lumped subsoil, boulders, and rock up of 1/3 cubic yard, measured by volume.

C. Perform excavation within 24 inches of existing utility service in accordance with utility's requirements.

D. Do not advance open trench more than 200 feet ahead of installed pipe.

E. Cut trenches to width indicated on Drawings. Remove water or materials that interfere with Work in accordance with Conservation District requirements and as shown on the Drawings.

F. Excavate bottom of trenches maximum 2 feet wider than outside diameter of pipe.

G. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and pipe.

H. Do not interfere with 45 degree bearing splay of foundations.

I. When Project conditions permit, slope side walls of excavation starting 2 feet above top of pipe. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this section.

J. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Professional until suitable material is encountered.

K. Cut out soft areas of subgrade not capable of compaction in place. Backfill with Structural Fill and compact to density equal to or greater than requirements for subsequent backfill material.

L. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.

M. Correct areas over excavated areas with compacted backfill as specified for authorized excavation or replace with fill concrete as directed by Professional.

N. Remove excess subsoil not intended for reuse, from site.

O. When performing work in or adjacent to an active roadway, ensure compliance with PennDOT standards for maintenance and protection of traffic.

3.4 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.

B. Support trenches excavated through unstable, loose, or soft material regardless of depth. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Design sheeting and shoring to be removed at completion of excavation work.

D. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

E. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.5 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen fill materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

C. Minimize compaction in area of infiltration basin.

D. Place material in continuous layers as follows:
   1. General Fill: Maximum 8 inches compacted depth.
   2. Structural Fill: Maximum 6 inches compacted depth.

E. Employ placement method that does not disturb or damage foundation perimeter drainage, utilities in trench.

F. Maintain optimum moisture content of fill materials to attain required compaction density.

G. Do not leave trench open at end of working day.

H. Protect open trench to prevent danger to the public.

3.6 TOLERANCES

A. Top Surface of Backfilling Under Paved Areas: Plus or minus ½ inch from required elevations.

B. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.7 FIELD QUALITY CONTROL

A. Perform all work in accordance with Section 31 23 16 - Excavation.

3.8 PROTECTION OF FINISHED WORK

A. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION

SECTION 31 2319
DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Dewatering system.
2. Surface water control system.
3. Monitoring wells.
4. System operation and maintenance.
5. Water disposal.

B. Related Sections:

1. Section 31 0516 - Aggregates for Earthwork: Filter sand.
2. Section 31 2316 - Excavation: Excavation for structures below ground water table.
3. Section 31 2316.13 - Trenching: Trenching for utilities below ground water table.
4. Section 31 2500 - Erosion Controls: Surface water runoff control.

1.3 REFERENCE STANDARDS

A. ASTM International:

1. ASTM C33 - Standard Specification for Concrete Aggregates.

B. PennDOT Publication 408, current edition.

C. PADEP Erosion and Sediment Pollution Control Program Manual, dated March 2012 and all corrections.

A. Geotechnical Exploration Report prepared by Maser Consulting dated August 26, 2020.

B. DEFINITIONS

C. Dewatering includes the following:

1. Lowering of ground water table and intercepting horizontal water seepage to prevent ground water from entering excavations, trenches, tunnels and shafts.
2. Reducing piezometric pressure within strata to prevent failure or heaving of excavations, trenches, tunnels and shafts.

3. Disposing of removed water.

D. Surface Water Control: Removal of surface water within open excavations.

1.4 SYSTEM DESCRIPTION

A. Provide dewatering and surface water control systems to permit Work to be completed on dry and stable subgrade. Use of pumped water filter bags in accordance with the Drawings.

1.5 PERFORMANCE REQUIREMENTS

A. Design dewatering systems to:

1. Lower water table within areas of excavation to minimum 2 feet below bottom of excavation to permit Work to be completed on dry and stable subgrade.
2. Relieve hydrostatic pressures in confined water bearing strata below excavation to eliminate risk of uplift or other instability of excavation.
3. Prevent damage to adjacent properties, buildings, structures, utilities, and facilities from construction operations.
4. Prevent loss of fines, quick condition, or softening of foundation subgrade.
5. Maintain stability of sides and bottoms of excavations and trenches, face, walls, and bottoms of tunnels, sides and bottoms of shafts.

B. Design surface water control systems to:

1. Collect and remove surface water and seepage entering excavation.

1.6 SUBMITTALS

A. Shop Drawings: Signed and sealed by licensed professional.

1. Indicate dewatering system layout, well depths, well screen lengths, dewatering pump locations, pipe sizes and capacities, grades, filter sand gradations, surface water control devices, valves, and water disposal method and location.
2. Indicate primary power system location and capacity.
3. Indicate layout and depth of monitoring wells, piezometers and flow measuring devices for system performance measurement.
4. Include detailed description of dewatering and monitoring system installation procedures and maintenance of equipment.
5. Include description of emergency procedures to follow when problems arise.

B. Product Data: Submit data for each of the following:

1. Dewatering Pumps: Indicate sizes, capacities, priming method, pump characteristics.
2. Pumping equipment for control of surface water within excavation.

C. Design Data: Signed and sealed by licensed professional.

1. Indicate design values, analyses, and calculations to support design.

2. Include description and profile of geology, soil, and groundwater conditions.

D. Field Reports: Test and monitoring reports as specified in Field Quality Control article.

1.7 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and depths of capped wells and piping abandoned in place.

1.8 QUALITY ASSURANCE

A. Comply with authorities having jurisdiction for the following:

1. Drilling and abandoning of wells used for dewatering systems.
2. Water discharge and disposal from pumping operations.

B. Perform Work in accordance with PennDOT, PADEP, and the Conservation District standards.

1.9 QUALIFICATIONS

A. Installer: Company specializing in performing work of this section with minimum 5 years documented experience and responsible for design, operation, and maintenance of dewatering system.

1. Assume sole responsibility for dewatering and surface water control systems and for loss or damage resulting from partial or complete failure of protective measures and settlement or resultant damage caused by ground water control operations.

B. Design, install, and monitor operation of dewatering under direct supervision of licensed professional experienced in design of this Work and licensed in State of Pennsylvania.

1.10 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.11 SEQUENCING

A. Sequence work to obtain required permits before start of dewatering operations.

B. Sequence work to install and test monitoring systems minimum 7 days before testing and operating dewatering systems.

C. Sequence work to install and test dewatering and surface water control systems minimum 7 days before starting excavation, trenching, tunneling and shaft drilling.

1.12 COORDINATION

A. Coordinate work to permit the following construction operations to be completed on dry stable substrate.

1. Excavation for structures specified in Section 31 2316.
2. Trenching for utilities specified in Section 31 2316.13.

PART 2 - PRODUCTS

2.1 DEWATERING EQUIPMENT

A. Select dewatering equipment to meet specified performance requirements listed on the Drawings.

B. Well Point: Sand casing type.

C. Furnish materials in accordance with PennDOT Publication 408, PADEP, and Conservation District Standards.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Conduct additional borings and investigations to supplement subsurface investigations identified as required to complete dewatering system design.

B. Contact Department not less than 5 working days before performing Work.

C. Call Local Utility Line Information service at 811 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

3.2 PREPARATION

A. Protect existing adjacent buildings, structures, and improvements from damage caused by dewatering operations.

3.3 DEWATERING SYSTEM

A. Install dewatering system in accordance with shop drawings.

B. Install Work in accordance with applicable Federal, State, County, PADEP, and Conservation District, and PennDOT Publication 408.

3.4 SURFACE WATER CONTROL SYSTEM

A. Provide ditches, berms, and other devices to divert and drain surface water from excavation area as specified in Section 31 2500 – Erosion Control.

B. Divert surface water and seepage water within excavation areas into sumps and pump water into drainage channels, settling basins, or water filter bags in accordance with requirements of agencies having jurisdiction.

C. Control and remove unanticipated water seepage into excavation.

3.5 SYSTEM OPERATION AND MAINTENANCE

A. Operate dewatering system continuously until backfilling is complete.

B. Provide 24-hour supervision of dewatering system by personnel skilled in operation, maintenance, and replacement of system components.

C. Conduct daily observation of dewatering system and monitoring system. Make required repairs and perform scheduled maintenance.

D. Fill fuel tanks before tanks reach 25 percent capacity.

E. Start emergency generators at least twice each week to check operating condition.

F. When dewatering system cannot control water within excavation, notify Professional and stop excavation work.

1. Supplement or modify dewatering system and provide other remedial measures to control water within excavation.
2. Demonstrate dewatering system operation complies with performance requirements before resuming excavation operations.

G. Modify dewatering and surface water control systems when operation causes or threatens to cause damage to new construction, existing site improvements, adjacent property, or adjacent water wells.

H. Correct unanticipated pressure conditions affecting dewatering system performance.

I. Do not discontinue dewatering operations without Professional's approval.

3.6 WATER DISPOSAL

A. Discharge water into settling pumped water filter bag prior to discharging to surface.

3.7 SYSTEM REMOVAL

A. Remove dewatering and surface water control systems after dewatering operations are discontinued.

3.8 FIELD QUALITY CONTROL

A. After dewatering system is installed, perform pumping test to determine when selected pumping rate lowers water level in well below pump intake. Adjust pump speed, discharge volume, or both to ensure proper operation of each pump.

B. Monitor and record the following, daily, until steady state conditions occur. Then monitor and record conditions twice each week.

1. Average discharge flow rate for each deep well, eductor header, and well point.

C. Monitor ground water discharge for contamination while performing pumping in vicinity of potentially contaminated sites. Sample and test water weekly for contaminates.

D. Submit initial installation reports including the following:

1. Installation and development reports for well points and pumps.
2. Initial dewatering flow rates.

E. Submit weekly monitoring reports including the following:

1. Dewatering flow rates.
2. Test reports of discharge water analysis.
3. Maintenance records for dewatering and surface water control systems.

END OF SECTION

SECTION 31 2323
FILL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Backfilling site structures to subgrade elevations.
2. Fill under slabs-on-grade.
3. Fill for over-excavation.
4. Fill under paving operations.
5. Fill for soil amendment areas.

B. Related Sections:
1. Section 03 30 00 – Cast-In-Place Concrete.
2. Section 31 00 00 - Earthwork
3. Section 31 05 13 – Soils for Earthwork.
4. Section 31 05 16 – Aggregates for Earthwork.
5. Section 31 22 13 – Rough Grading.
6. Section 31 23 16 – Excavation.
7. Section 31 23 16.13 – Trenching.
8. Section 31 25 00 – Erosion Control.
9. Section 32 91 19 – Landscape Grading.
10. Section 33 05 16.13 – Precast Concrete Utility Structures.
11. Section 33 41 00 – Storm Utility Drainage Piping.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
2. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
4. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
7. ASTM D4253 – Standard test method for maximum index density and unit weight of soils and calculation of relative density.
8. ASTM D4254 – Standard test method for minimum index density and unit weight of soils and calculation of relative density.

C. PennDOT Publication 408, current edition.

D. PADEP Erosion and Sediment Pollution Control Program Manual, dated March 2012 and all corrections

A. Geotechnical Exploration Report prepared by Maser Consulting dated August 26, 2020.

B. SUBMITTALS

C. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

D. Materials Source: Submit name of imported fill materials suppliers.

E. Manufacturer's Certificate: Certify Products meet or exceed PADEP requirements for clean fill.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with PennDOT Publication 408.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. General Fill: As specified in Section 31 05 13 – Soils for Earthwork.

B. Structural Fill: Soil meeting AASHTO standards for A-2-4, A-2-6, A-4, A-6, or #57

2.2 ACCESSORIES – NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

3.2 PREPARATION

A. Compact subgrade to density requirements for subsequent backfill materials.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with structural fill and compact to density equal to or greater than requirements for subsequent fill material.

C. Scarify subgrade surface to depth of 6 inches.

D. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

3.3 BACKFILLING

A. Backfill areas to contours and elevations with unfrozen materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.

C. Place material in continuous layers as follows:
   1. General Fill: Maximum 8 inches compacted depth.
   2. Structural Fill: Maximum 6 inches compacted depth.

D. Employ placement method that does not disturb or damage other work.

E. Maintain optimum moisture content of backfill materials to attain required compaction density.

F. Make gradual grade changes. Blend slope into level areas.

G. Remove surplus backfill materials from site.

H. Leave fill material stockpile areas free of excess fill materials.

I. Structural fill shall be compacted to at least 95 percent of the laboratory determined dry density as determined by ASTM D1557 for footings and slab on grade.

3.4 TOLERANCES

A. Top Surface of Backfilling: Plus or minus 1 inch from required elevations.

3.5 FIELD QUALITY CONTROL

A. Perform all work in accordance with Section 31 23 16 – Excavation

B. Periodically test the fill material for the presence of expansive pyritic material. If any expansive material is detected or suspected, do not use fill material within 5 feet below the floor slab, and 3 feet below the footing and pavement.

C. Samples of possible borrow material should be collected and tested prior to the site work to determine the maximum dry density, optimum moisture content, gradation and plasticity characteristics. These tests are necessary to control the quality of the fill material and determine the controlling parameter for field compaction. Most importantly, fill must be free from unacceptable pyrite content. Special attention needs to be paid to shale rock as more often than not they are found to be pyritic.

3.6 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.

B. Reshape and re-compact fills subjected to vehicular traffic.

3.7 SOIL LOOSENING

A. Perform in accordance with Drawings.

3.8 SOILS AMENDMENT AND RESTORATION

A. Perform in accordance with Drawings.

END OF SECTION

SECTION 31 2500
EROSION CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. This section includes various erosion and sedimentation (E&S) control and post-construction stormwater management (PCSM) devices that may function in any particular combination as an erosion control system for transportation and site development applications. This work shall consist of temporary control measures ordered by the Professional during the life of the contract and as shown on the plans, to control erosion and sediment with dikes, berms, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, and other erosion control devices or methods.

B. The temporary control provisions contained herein shall be coordinated with the permanent erosion control features (grass, pavement and other restorations) specified elsewhere in the contract to the extent practical to assure economical, effective and continuous erosion control throughout the construction and post-construction period.

C. Temporary erosion control measures shall be implemented for each phase of construction, which will necessitate relocating, adding, or modifying E&S Controls as directed by the Conservation District, Department, or Professional.

D. The erosion control measures described herein shall be continued until the construction is complete and final restorations installed.

E. Section Includes:

1. E&S Controls as detailed on the Drawings.
2. PCSM Best Management Practices as detailed on the Drawings
3. As-Built drawings in accordance with the Notice of Termination As-Built Checklist.
4. Critical Stage Site Inspections by a Licensed Professional or Designee as detailed on the Drawings including their certification on the Notice of Termination.

F. Related Sections:

1. Section 31 0513 - Soils for Earthwork.
2. Section 31 0516 - Aggregates for Earthwork.
3. Section 31 1000 - Site Clearing.
4. Section 31 2316 - Excavation.
5. Section 31 2323 - Fill.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T88 - Standard Specification for Particle Size Analysis of Soils.
2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete.

C. ASTM International:

1. ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
4. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

D. Precast/Prestressed Concrete Institute:

1. PCI MNL-116S - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

E. PennDOT Publication 408, current edition.

F. PADEP Erosion and Sediment Pollution Control Program Manual, dated March 2012 and all corrections.

G. Geotechnical Exploration Report prepared by Maser Consulting dated August 26, 2020.

H. SUBMITTALS

I. Product Data: Submit data on geotextile.

1.5 CLOSEOUT SUBMITTALS

A. Provide final inspection certification.

B. Contractor to provide as-built drawings in accordance with the PADEP's Notice of Termination (NOT) Record Drawings (accurately reflecting as-built conditions) Checklist

for a General (PAG-02) NPDES permit for Stormwater Discharges Associated with Construction Activities, current version.

APPENDIX B
Record Drawings (accurately reflecting as-built conditions) Checklist

Permit No.: _____

Indicate whether each item is included or not applicable		
		Building Improvements
Included	**Not Applicable**	**Item**
☐	☐	Building Footprint
☐	☐	Limits of Paving and other impervious areas
☐	☐	Property Lines
☐	☐	Finish Grading
☐	☐	Downspout Locations
		Site Utilities
Included	**Not Applicable**	**Item**
☐	☐	Well location
☐	☐	Septic tanks, dosing tanks, distribution boxes and on-lot absorption area
		Stormwater Conveyance
Included	**Not Applicable**	**Item**
☐	☐	Pipe locations including pipe material, diameter, slope and length
☐	☐	Inlets and endwall locations including inverts and grate elevations
☐	☐	Swale locations and dimensions
☐	☐	Rock aprons and other pipe outlets locations
		Post Construction Storm Water Management (PCSM)
Included	**Not Applicable**	**Item**
☐	☐	Structural PCSM BMP locations and access
☐	☐	Non-Structural PCSM BMP locations
☐	☐	Construction details of PCSM BMPs in as-built condition
☐	☐	BMP berm elevations
☐	☐	BMP bottom elevations
☐	☐	Emergency spillway elevation
☐	☐	Emergency spillway length
☐	☐	Emergency spillway protection (TRW, Riprap, etc.)
☐	☐	Outlet structure elevations, orifice sizes
☐	☐	Pipe size, length, material, elevations and slope
☐	☐	Show all rain barrels, seepage pits, infiltration trenches
☐	☐	Show limits (soil amendments, new wood line, etc.)
☐	☐	Cover condition (lawn, meadow, woods, etc.)
☐	☐	PCSM BMP Long-Term O&M
		PCSM – Irrigation BMPs only
Included	**Not Applicable**	**Item**
☐	☐	Spray Head and Valve Locations and Spray Radii
☐	☐	Pump Location
☐	☐	Pump Information (Duty point, HP)
☐	☐	Controller Location
☐	☐	Intake Location
☐	☐	Location of main (size and material)
☐	☐	Laterals (size and material)
☐	☐	Dosing Schedule
☐	☐	Drip Field with tubing location

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with 25 Pa. Code, Chapter 102; PADEP Erosion and Sediment Pollution Control Program Manual; and PennDOT Publication 408 standards. In the event of conflict between these requirements and pollution control laws, rules, or regulation of other federal, state, or local agencies, the more restrictive law, rule, or regulation shall govern.

1.7 PRE-INSTALLATION MEETINGS

A. Set-up a pre-construction meeting a minimum of one week prior to commencing any work on the property with representatives of the Department, Professional, and Conservation District.

PART 2 - PRODUCTS

2.1 ROCK AND GEOTEXTILE MATERIALS

A. Rock: Furnish in accordance with the Drawings and with Section 31 05 16 – Aggregates for Earthwork.

B. Geotextile Fabric: Furnish in accordance with the Drawings and with Section 31 05 19.13 – Geotextiles for Earthwork.

2.2 PLANTING MATERIALS

A. Seeding and Soil Supplements: As specified on the Drawings and in Section 32 92 19 - Seeding. Furnish in accordance with drawings and PennDOT Publication 408 Standards.

B. Mulch: as specified in Section 32 92 19 - Seeding. Furnish in accordance with Drawings, Conservation District, and PennDOT Publication 408 Standards.

2.3 PIPE MATERIALS

A. Cleaning of existing and proposed structures and pipes filled with sediment: Includes the removal, hauling, and disposal of sediment and other debris in the system.

B. Any deviation from the materials shown on the Drawings requires submission of a stormwater analysis, using the same methodologies and programs as the design, to prove the equivalent material exceeds the materials on the Drawings as well as submissions to all affected reviewing agencies to modifications to their permits. Absent of this information, the contractor is to pay the professional for the necessary calculations to prove the materials exceed the designed material as well as for any changes to permits.

2.4 MIXES

A. Compost Mix: As specified on the Drawings and in Section 31 05 13 – Soils for Earthwork.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify compacted subgrade is acceptable and ready to support devices and imposed loads.

B. Verify gradients and elevations of base or foundation for other work are correct.

3.2 ROCK CONSTRUCTION ENTRANCE

A. Install at the locations specified and in accordance with the Drawings.

B. Follow inspection, maintenance, and repair information as listed on the Drawings.

3.3 COMPOST FILTER SOCKS

A. Install at the locations specified and in accordance with the Drawings.

B. Follow inspection, maintenance, and repair information as listed on the Drawings.

3.4 INLET PROTECTION

A. Install at the locations specified and in accordance with the Drawings.

B. Follow inspection, maintenance, and repair information as listed on the Drawings.

3.5 EROSION CONTROL LINING

A. Install when grades exceed 3:1 slopes and at the locations specified and in accordance with the Drawings.

B. Follow inspection, maintenance, and repair information as listed on the Drawings.

3.6 CONSTRUCTION FENCING

A. Install at the locations specified and in accordance with the Drawings.

B. Follow inspection, maintenance, and repair information as listed on the Drawings.

3.7 SOILS AMENDMENTS AND RESTORATION

A. Follow inspection, maintenance, and repair information as listed on the Drawings and in Section 31 2323 - Fill.

3.8 PUMPED WATER FILTER BAG

A. Follow inspection, maintenance, and repair information as listed on the Drawings and in Section 31 2319 - Dewatering.

3.9 ROCK FILTER OUTLET

A. Follow inspection, maintenance, and repair information as listed on the Drawings.

3.10 SITE STABILIZATION

A. Incorporate erosion control devices indicated on the Drawings into the Project at the earliest practicable time.

B. Construct, stabilize and activate erosion controls before site disturbance within tributary areas of those controls.

C. Stockpile and waste pile heights shall not exceed 35 feet. Slope stockpile sides at 2: 1 or flatter.

D. Stabilize any disturbed area of affected erosion control devices on which activity has ceased and which will remain exposed for more than 20 days.

1. During non-germinating periods, apply mulch at recommended rates.
2. Stabilize disturbed areas which are not at finished grade and which will be disturbed within one-year in accordance with Section 32 92 19 - Seeding at 75% percent of permanent application rate with no topsoil.
3. Stabilize disturbed areas which are either at finished grade or will not be disturbed within one-year in accordance with Section 32 92 19 - Seeding permanent seeding specifications.

3.11 FIELD QUALITY CONTROL

A. Inspect erosion control devices on a weekly basis and after each runoff event. Make necessary repairs to ensure erosion and sediment controls are in good working order. Provide photographs to document site conditions.

B. Provide Professional with 48 hours prior notice for inspection of critical stage inspections as listed on the Project Drawings. Photo document all critical stages of construction.

3.12 CLEANING

A. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device, remove and dispose of sediment.

B. Do not damage structure or device during cleaning operations.

C. Do not permit sediment to erode into construction or site areas or natural waterways.

D. Clean channels when depth of sediment reaches approximately one-half channel depth.

3.13 PROTECTION

A. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit sediment to erode into construction or site areas or natural waterways

C. Protect infiltration area from receiving sediment laden water or compaction. Install orange safety fence around perimeter of infiltration area prior to construction.

END OF SECTION

SECTION 32 1123
AGGREGATE BASE COURSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Aggregate subbase.

B. Related Sections:

1. Section 31 0516 - Aggregates for Earthwork.
2. Section 31 2213 - Rough Grading.
3. Section 31 2316.13 - Trenching.
4. Section 31 2323 - Fill.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
2. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
4. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

C. PennDOT Publication 408, current edition.

1.5 SUBMITTALS

A. Product Data:

1. Submit data for geotextile fabric.

B. Materials Source: Submit name of aggregate materials suppliers.

C. Manufacturer's Certificate: Certify Products meet or exceed PennDOT Publication 408 standards.

1.6 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work in accordance with PennDOT Publication 408 standard.

PART 2 - PRODUCTS

2.1 AGGREGATE MATERIALS

A. Subbase Aggregate: PennDOT Type 2A, in accordance with PennDOT Publication 408.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify compacted substrate is dry and ready to support paving and imposed loads.

1. Proof roll substrate with 20 ton vibratory roller in minimum two perpendicular passes to identify soft spots.
2. Remove soft substrate and replace with compacted fill as specified in Section 31 2323 - Fill.

B. Verify substrate has been inspected, gradients and elevations are correct.

3.2 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place fill on soft, muddy, or frozen surfaces.

3.3 AGGREGATE PLACEMENT

A. Spread aggregate over prepared substrate to total compacted thickness indicated on Drawings.

B. Roller compact aggregate to 95 percent maximum density.

C. Level and contour surfaces to elevations, profiles, and gradients indicated.

D. Add small quantities of fine aggregate to coarse aggregate when required to assist compaction.

E. Maintain optimum moisture content of fill materials to attain specified compaction density.

F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.4 TOLERANCES

A. Maximum Variation From Flat Surface: ½ inch measured with 10 foot straight edge.

B. Maximum Variation From Thickness: 1/4 inch.

C. Maximum Variation From Elevation: 1/2 inch.

3.5 FIELD QUALITY CONTROL

A. Compaction testing will be performed in accordance with AASHTO T310.

B. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

C. Frequency of Tests: One test for every 1000 square yards of each layer compacted aggregate.

END OF SECTION

SECTION 32 1216
ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Asphalt materials.
2. Aggregate materials.
3. Aggregate subbase.
4. Asphalt paving base course, binder course, and wearing course.

B. Related Sections:

1. Section 31 23 23 - Fill.
2. Section 31 05 16 - Aggregates for Earthwork.
3. Section 32 17 23 – Pavement Markings.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M17 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
2. AASHTO M29 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
3. AASHTO M140 - Standard Specification for Emulsified Asphalt.
4. AASHTO M208 - Standard Specification for Cationic Emulsified Asphalt.
5. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
6. AASHTO M320 - Standard Specification for Performance-Graded Asphalt Binder.
7. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
8. AASHTO MP1a - Standard Specification for Performance-Graded Asphalt Binder.

B. Asphalt Institute:

1. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot- Mix Types.
2. AI MS-19 - Basic Asphalt Emulsion Manual.

3. AI SP-2 - Superpave Mix Design.

C. ASTM International:

1. ASTM D242 - Standard Specification for Mineral Filler For Bituminous Paving Mixtures.
2. ASTM D692 - Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.
3. ASTM D977 - Standard Specification for Emulsified Asphalt.
4. ASTM D1073 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
5. ASTM D1188 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
6. ASTM D2027 - Standard Specification for Cutback Asphalt (Medium-Curing Type).
7. ASTM D2397 - Standard Specification for Cationic Emulsified Asphalt.
8. ASTM D2950 - Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
9. ASTM D3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
10. ASTM D3515 - Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
11. ASTM D3549 - Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
12. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
13. ASTM E408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.

D. PennDOT Publication 72M, RC Standards, current edition.

E. PennDOT Publication 408, current edition.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:
1. Submit product information for asphalt and aggregate materials.
2. Submit mix design with laboratory test results supporting design.

C. Manufacturer's Certificate: Certify Products meet or exceed PennDOT Publication 408 standards.

1.6 QUALITY ASSURANCE

A. Mixing Plant: Conform to PennDOT Publication 408 standards.

B. Obtain materials from same source throughout.

C. Perform Work in accordance with PennDOT Publication 408 standards.

1.7 QUALIFICATIONS

A. Installer: Company specializing in performing work of this section with minimum 5 years documented experience.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not place asphalt mixture when ambient air or base surface temperature is less than 40 degrees F, surface is wet or frozen, or outside of the paving dates listed in PennDOT Publication 408 unless approved by the Professional.

PART 2 - PRODUCTS

2.1 ASPHALT MATERIALS

A. Asphalt Cement: In accordance with PennDOT Publication 408 standards.

B. Tack Coat: In accordance with PennDOT Publication 408 standards.

2.2 AGGREGATE MATERIALS

A. Coarse Aggregate: In accordance with Section 31 05 16 – Aggregates for Earthwork. In accordance with PennDOT Publication 408 standards.

B. Fine Aggregate: ASTM D1073 AASHTO M29; natural sand or sand manufactured from stone, gravel, or blast furnace slag. In accordance with PennDOT Publication 408 standards.

2.3 MIXES

A. Use dry material to avoid foaming. Mix uniformly.

B. Asphalt Paving Mixtures: Designed in accordance with PennDOT Publication 408 standards.

1. Base Course: As indicated on the drawings.
2. Binder Course: As indicated on the drawings.
3. Wearing Course: As indicated on the drawings.

2.4 SOURCE QUALITY CONTROL

A. Submit proposed mix design of each class of mix for review prior to beginning of Work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.

B. Verify compacted subbase is dry and ready to support paving and imposed loads.

1. Prepare subbase in accordance with Section 350 of PennDOT Publication 408
2. Remove soft subbase and replace with compacted fill as specified in Section 31 23 23 – Fill.

C. Verify gradients and elevations of base are correct.

D. Verify gutter drainage grilles and frames and manhole frames are installed in correct position and elevation.

3.2 SUBBASE

A. Prepare subbase in accordance with Section 350 PennDOT Publication 408 standards.

3.3 EXISTING WORK

A. Saw cut and notch existing paving.

B. Clean existing paving to remove foreign material, excess joint sealant and crack filler from paving surface.

C. Repair surface defects in existing paving to provide uniform surface to receive new paving.

3.4 TACK COAT

A. Apply tack coat in accordance with PennDOT Publication 408 standards, Section 460.

B. Apply tack coat to contact surfaces of curbs and gutters.

C. Coat surfaces of manhole and catch basin frames with oil to prevent bond with asphalt paving. Do not tack coat these surfaces.

3.5 SINGLE COURSE ASPHALT PAVING

A. Install Work in accordance with PennDOT Publication 408 standards.

B. Place asphalt within 24 hours of applying primer or tack coat.

C. Place asphalt wearing course to thickness indicated on Drawings.

D. Compact paving by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.

E. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

F. All asphalt constructed and replaced shall be installed to like new conditions. Infra-red paving may be required to meet the joints of the sawcut asphalt as determined in the field by the Department's representative. There shall be no additional cost for this type of construction.

3.6 ERECTION TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

B. Scheduled Compacted Thickness: Within 1/4 inch.

C. Variation from Indicated Elevation: Within 1/2 inch.

3.7 FIELD QUALITY CONTROL

A. Install work in accordance with PennDOT Publication 408 standards.

3.8 PROTECTION OF FINISHED WORK

A. Immediately after placement, protect paving from mechanical injury for 24 hours or until surface temperature is less than 140 degrees F.

END OF SECTION

SECTION 32 1313
CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Aggregate subbase.
2. Concrete paving for:
   a. Concrete sidewalks and pads.
   b. Concrete slabs for loading areas.
   c. Concrete stair steps.
   d. Concrete curbs.
   e. Concrete sidewalks with underslab heating

B. Related Sections:

1. Section 03 3000 – Cast in Place Concrete
2. Section 31 0000 - Earthwork
3. Section 31 2213 - Rough Grading: Preparation of site for paving and base.
4. Section 31 2323 - Fill: Compacted subbase for paving.
5. Section 32 1123 - Aggregate Base Courses.
6. Section 32 1216 - Asphalt Paving.
7. Section 32 9119 - Landscape Grading: Preparation of subsoil at pavement perimeter.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT - NOT USED

1.4 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

B. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete.
2. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.

C. ASTM International:

1. ASTM A184/A184M - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
2. ASTM A185/A185M - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
3. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
4. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
5. ASTM C33 - Standard Specification for Concrete Aggregates.
6. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
7. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
8. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.
9. ASTM C150 - Standard Specification for Portland Cement.
10. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
11. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
12. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
13. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
14. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
15. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
16. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
17. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.
18. ASTM C1017/C1017M - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
19. ASTM C1064/C1064M - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
20. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
21. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
22. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
23. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
24. ASTM E408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.

D. PennDOT Publication 72M, RC Standards, current edition.

E. PennDOT Publication 408, current edition.

1.5 PERFORMANCE REQUIREMENTS – NOT USED

1.6 SUBMITTALS

A. Product Data:

1. Submit data on concrete materials, joint filler, admixtures, curing compounds.
2. Submit data on fiber-reinforced concrete for sidewalks

B. Design Data:

1. Submit concrete mix design for each concrete strength. Submit separate mix designs when admixtures are required for the following:

a. Hot and cold weather concrete work.

2. Identify mix ingredients and proportions, including admixtures.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301 and Section 03 3000 – Cast-in-Place Concrete.

B. Obtain cementitious materials from same source throughout.

C. Install underslab heating piping at locations shown on the drawings.

D. Perform Work in accordance with PennDOT Publication 408 standards.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum 3 years' experience.

1.9 MOCKUP – NOT USED

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not place concrete when base surface temperature is less than 40 degrees F, surface is wet or frozen, or outside of the paving dates listed in PennDOT Publication 408 unless approved by the Professional.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Form Materials: Conform to ACI 301. Use flexible or curved forms for curves with a radius of 100 feet or less.

B. Form Release Agent: Commercially formulated form-release agent with a maximum of 350 g/L volatile organic compound (VOC's) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

C. Joint Filler: ASTM D1751; Asphalt impregnated fiberboard or felt, 1/2 inch thick.

2.2 REINFORCING

A. Reinforcing Steel and Wire Fabric: ASTM A 615, Grade 60; deformed

B. Fiber reinforcement: ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete

C. Welded Plain Wire Fabric: ASTM A185/A185M; in flat sheets.

2.3 CONCRETE MATERIALS

A. Concrete Materials: As specified in Section 03 30 00 – Cast-in-Place Concrete. Provide in accordance with PennDOT Publication 408 standards.

B. Fine and Coarse Aggregates: ASTM C33.

C. Water: ASTM C94/C94M; potable, not detrimental to concrete.

D. Air Entrainment: ASTM C260.

E. Chemical Admixture: ASTM C494/C494M.

1. Type A - Water Reducing.
2. Type B - Retarding.

2.4 ACCESSORIES

A. Curing Compound: Per PennDOT Publication 408 standards.

B. Joint Sealers: Per PennDOT Publication 408 standards.

C. Bonding Agent: ASTM C1059, Type II, non-redipersible, acrylic emulsion or styrene butadiene.

D. Vapor Barrier – 20 mil Polyethylene

E. Rigid Insulation – 2” R10 High Density Polystyrene

2.5 CONCRETE MIX - BY PERFORMANCE CRITERIA

A. Mix and deliver concrete in accordance with PennDOT Publication 408.

B. Select proportions for normal weight concrete in accordance with ACI 301.

C. Provide concrete to the following criteria:

1. Compressive Strength: 4,500 psi at 28 days or per plans.
2. Slump: 1 to 3 inches. Slump limit for concrete containing high-range water reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to site verified 2-3 inch slump concrete.

3. Maximum Water/Cement Ratio: .045
4. Air Entrainment: ASTM C94/C94M; for moderate exposure condition; maximum variation of 1.5 percent from required air content.

D. Use accelerating admixtures in cold weather only when approved by the Professional in writing. Use of admixtures will not relax cold weather placement requirements.

E. Use calcium chloride only when approved by the Professional in writing.

F. Use set retarding admixtures during hot weather only when approved by the Professional in writing.

2.6 CONCRETE MIX - BY PRESCRIPTIVE CRITERIA- NOT USED

2.7 SOURCE QUALITY CONTROL AND TESTS

A. Submit proposed mix design of each class of concrete to appointed firm for review prior to commencement of Work.

B. Tests on cement, aggregates, and mixes will be performed to ensure conformance with specified requirements.

C. Test samples in accordance with PennDOT Publication 408

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify compacted subgrade is dry and ready to support paving and imposed loads.

1. Remove soft subbase and replace with compacted fill as specified in Section 31 23 23 – Fill.

B. Verify gradients and elevations of base are correct.

C. Confirm locations of underslab heating tubing connections to building.

3.2 SUBBASE

A. Aggregate Subbase: Install as specified in Section 32 11 23 – Fill.

B. Prepare subbase in accordance with PennDOT Publication 408 standards.

3.3 PREPARATION

A. Moisten substrate to minimize absorption of water from fresh concrete.

B. Coat surfaces of manhole and catch basin frames with oil to prevent bond with concrete paving.

C. Notify Professional minimum 24 hours prior to commencement of concreting operations.

3.4 FORMING

A. Place and secure forms and screeds to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

3.5 REINFORCING

A. Place reinforcing as indicated on Drawings.

B. Interrupt reinforcing at contraction or expansion joints.

3.6 PLACING CONCRETE

A. Place concrete in accordance with PennDOT Publication 408 standards.

B. Ensure reinforcing, inserts, embedded parts, formed joints are not disturbed during concrete placement.

C. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

3.7 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. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints. Continue steel across joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated. Use bonding agent at butt joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Isolation Joints: Form isolation joints or preformed joint filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
   1. Locate expansion joints at 20 foot intervals. Align curb, gutter, and sidewalk joints.
   2. Extend joint fillers full width and depth of joint
   3. Place top of joint filler flush with concrete surface if joint sealant is not indicated.
   4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint filler sections together.
   5. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, if permitted, as follows:

E. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8" wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction joints. Unless otherwise shown, place joints not to exceed 25 square feet. In curbs, place joints at 10 foot on centers.

F. Provide keyed joints as indicated.

3.8 FINISHING

A. Sidewalk Paving: Light broom, radius to 3/4-inch radius, and trowel joint edges. Wood float.

B. Curbs and Gutters: Light broom.

C. Direction of Texturing: Transverse to paving direction.

D. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 3/8" radius; ¾" at curbs. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.9 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

C. Cure floor surfaces in accordance with PennDOT Publication 408 standards.

3.10 ERECTION TOLERANCES

A. Maximum Variation of Surface Flatness: ¼ inch in 10 ft.

B. Thickness: Plus 3/8", minus ¼"

C. Contraction Joint Depth: Plus ¼", no minus.

D. Joint Width: Plus 1/8", no minus

E. Maximum Variation From True Position: 1/4 inch.

3.11 FIELD QUALITY CONTROL

A. Department will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports. Test results will be reported in writing to Professional, concrete manufacturer, and Contractor within 48 hours of testing.

B. Additional tests will be made when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Professional. Any concrete

that test results indicate that it does not comply with specified requirements shall be removed and replaced.

C. All costs for retesting and inspections performed to determine compliance of replaced or additional work shall be borne by the Contractor.

3.12 PROTECTION

A. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit pedestrian or vehicular traffic over paving for 14 days minimum after finishing. Until 75 percent design strength of concrete has been achieved.

C. Maintain concrete pavement free from stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than 2 days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 1723
PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Traffic lines and markings.
2. Legends.
3. Paint.
4. Glass beads.

B. Related Sections:

1. Section 32 1216 - Asphalt Paving.
2. Section 32 1313 - Concrete Paving.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M247 - Standard Specification for Glass Beads Used in Traffic Paint.

B. ASTM International:

1. ASTM D34 - Standard Guide for Chemical Analysis of White Pigments.
2. ASTM D711 - Standard Test Method for No-Pick-Up Time of Traffic Paint.
3. ASTM D713 - Standard Practice for Conducting Road Service Tests on Fluid Traffic Marking Materials.
4. ASTM D969 - Standard Test Method for Laboratory Determination of Degree of Bleeding of Traffic Paint.
5. ASTM D1301 - Standard Test Methods for Chemical Analysis of White Lead Pigments.
6. ASTM D1394 - Standard Test Methods for Chemical Analysis of White Titanium Pigments.
7. ASTM D1475 - Standard test Method for Density of Liquid Coatings, Inks, and Related Products.
8. ASTM D2202 - Standard Test Method for Slump of Sealants.
9. ASTM D2371 - Standard Test Method for Pigment Content of Solvent-Reducible Paints.

10. ASTM D2621 - Standard Test Method for Infrared Identification of Vehicle Solids From Solvent-Reducible Paints.
11. ASTM D2743 - Standard Practices for Uniformity of Traffic Paint Vehicle Solids by Spectroscopy and Gas Chromatography.

C. PennDOT Publication 408, current edition.

D. PennDOT Publication 35 (Bulletin 15).

1.5 PERFORMANCE REQUIREMENTS

A. Paint Adhesion: Adhere to road surface forming smooth continuous film one minute after application.

B. Paint Drying: Tack free by touch so as not to require coning or other traffic control devices to prevent transfer by vehicle tires within two minutes after application.

1.6 SUBMITTALS

A. Product Data: Submit paint formulation for each type of paint.

B. Test Reports: Submit source and acceptance test results in accordance with AASHTO M247.

C. Manufacturer's Installation Instructions: Submit instructions for application temperatures, eradication requirements, application rate, line thickness, type of glass beads, bead embedment and bead application rate, and any other data on proper installation.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with PennDOT Publication 408 standards.

1.8 QUALIFICATIONS

A. Applicator: Company specializing in performing work of this section with minimum 5 years experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 6000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Invert containers several days prior to use when paint has been stored more than 2 months. Minimize exposure to air when transferring paint. Seal drums and tanks when not in use.

C. Glass Beads. Store glass beads in cool, dry place. Protect from contamination by foreign substances.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Section 01 6000 - Product Requirements: Environmental conditions affecting products on site.

B. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by paint product manufacturer.

C. Do not apply exterior coatings during rain or snow when relative humidity is outside humidity ranges, or moisture content of surfaces exceed those required by paint product manufacturer.

D. Do not apply paint when temperatures are expected to fall below 50 degrees F for 24 hours after application.

E. Volatile Organic Content (VOC). Do not exceed State or Environmental Protection Agency maximum VOC on traffic paint.

1.11 WARRANTY

A. Furnish three-year manufacturer's warranty for traffic paints.

1.12 MAINTENANCE SERVICE

A. See Division 01 requirements for maintenance service.

PART 2 - PRODUCTS

2.1 PAINTED PAVEMENT MARKINGS

A. Furnish materials in accordance with PennDOT Publication 408 standards, and PennDOT Bulletin 15.

B. Paint: In accordance with Section 962 of PennDOT Publication 408. Parking Areas: White, Type I, as specified as shown on the Drawings; Blue for ADA Spaces. Road Centerlines: Yellow, as specified as shown on the Drawings.

2.2 THERMOPLASTIC MARKINGS

A. Comply with PennDOT Publication 35 (Bulletin 15).

B. Use hydrocarbon or alkyd based hot thermoplastic markings for Turn Arrows, Stop Bars, Crosswalks, Gore Areas.

2.3 EQUIPMENT

A. For application of crosswalks, intersections, stop lines, legends and other miscellaneous items by walk behind stripers, hand spray or stencil trucks, apply with equipment meeting requirements of this section. Do not use hand brushes or rollers. Optionally apply glass beads by hand.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not apply paint to concrete surfaces until concrete has cured for 28 days.

3.2 PREPARATION

A. Maintenance and Protection of Traffic:

1. Provide short term traffic control in accordance with Division 01 requirements.
2. Prevent interference with marking operations and to prevent traffic on newly applied markings before markings dry.
3. Maintain travel lanes between 7:00 AM to 9:00 AM, and between 4:00 PM and 6:00 PM.

B. Surface Preparation.

1. Clean and dry paved surface prior to painting.
2. Blow or sweep surface free of dirt, debris, oil, grease, or gasoline.

3.3 APPLICATION

A. Install Work in accordance with Section 962 PennDOT Publication 408 standards.

B. Apply paint with mechanical equipment to produce uniform straight edges. Apply in a wet film thickness of 15 mils.

C. Glass Bead application rate: 8 to 10 lbs per 100 s.f.

D. Apply thermoplastic markings at a temperature between 400-440 degrees F. Thickness for new application shall be 90 mils.

3.4 APPLICATION TOLERANCES

A. Maximum Variation from Wet Film Thickness: 1 mil.

B. Maximum Variation from Wet Paint Line Width: Plus or minus 1/8 inch.

3.5 FIELD QUALITY CONTROL

A. Inspect for incorrect location, insufficient thickness, line width, coverage, retention, uncured or discolored material, and insufficient bonding.

B. Repair lines and markings, which after application and curing do not meet following criteria:

1. Incorrect Location: Remove and replace incorrectly placed patterns.
2. Insufficient Thickness, Line Width, Paint Coverage, Glass Bead Coverage or Retention: Prepare defective material by acceptably grinding or blast cleaning to remove substantial amount of beads and to roughen marking surface. Remove loose particles and debris. Apply new markings on cleaned surface in accordance with this Section.

3. Uncured or Discolored Material, Insufficient Bonding: Remove defective markings in accordance with this Section and clean pavement surface one foot beyond affected area. Apply new markings on cleaned surface in accordance with this Section.

C. Replace defective pavement markings as specified throughout 3 year warranted period. Replace markings damaged by anti-skid materials, studded tires, tire chains, chemical deicers, snow plowing or other loss of marking material regardless of cause. When markings are damaged by pavement failure or by Department's painting, crack sealing, or pavement repair operations, Contractor is released from warranty requirements for damaged work.

D. Prepare list of defective areas and areas requiring additional inspection and evaluation to decide where material may need to be replaced. Provide traffic control as necessary if markings require more detailed evaluation.

E. Replace pavement marking material under warranty using original or better type material. Continue warranty to end of original 3 year period even when replacement materials have been installed as specified.

F. When eradication of existing paint lines is necessary, eradicate by shot blast or water blast method. Do not gouge or groove pavement more than 1/16 inch during removal. Limit area of removal to area of marking plus 1 inch on all sides. Prevent damage to transverse and longitudinal joint sealers, and repair any damage according to requirements in Section 32 1313 – Concrete Paving, or Section 32 1216 – Asphalt Paving.

G. Maintain daily log showing work completed, results of above inspections or tests, pavement and air temperatures, relative humidity, presence of any moisture on pavement, and any material or equipment problems. Make legible entries in log in ink, sign and submit by end of each work day. Enter environmental data into log prior to starting work each day and at two additional times during day.

3.6 PROTECTION OF FINISHED WORK

A. Protect painted pavement markings from vehicular and pedestrian traffic until paint is dry and track free. Follow manufacturer's recommendations or use minimum of 30 minutes. Consider barrier cones as satisfactory protection for materials requiring more than 2 minutes dry time.

END OF SECTION

SECTION 32 1726

TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. The extent of work under this Section is shown on the drawings and hereinafter specified.

B. Included in this work is, but is not limited to, the following:

1. Cast-in-Place Detectable/Tactile Warning Surface Tiles which comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act.

C. Related Section:

1. Section 03 3000 – Cast-in-Place Concrete.
2. Section 32 1216 – Asphalt Paving.
3. Section 32 1313 – Concrete Paving.

1.3 UNIT PRICE – MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCES

A. U.S. Architectural and Transportation Barriers Compliance Board (Access Board):

1. Americans with Disabilities Act (ADA) - Accessibility Guidelines for Buildings and Facilities.

B. PennDOT Publication 408, current edition.

C. PennDOT Publication 35 (Bulletin 15).

D. PennDOT Publication 72M, RC Standards, current edition.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer’s literature describing products, installation procedures and routine maintenance.

B. Shop Drawings: For products specified showing fabrication details, composite structural system, tile surface profile, sound on cane contact amplification feature, plans of tile placement including joints, and material to be used as well as outlining installation materials and procedure.

C. Material Test Reports: Submit complete test reports from qualified accredited independent testing laboratories to qualify that materials proposed for use are following requirements and meet or exceed the properties indicated on the specifications. All tests shall be conducted on a Cast In Place Detectable/Tactile Warning Surface Tile system as certified by a qualified independent testing laboratory and be current within a 24-month period.

D. Maintenance Instructions: Submit copies of manufacturer's specified installation and maintenance practices for each type of Detectable Warning Surface Tile and accessory as required.

1.6 DELIVERY AND STORAGE

A. Cast In Place Detectable/Tactile Warning Surface Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy plastic wrappings to protect tile from concrete residue during installation and tile type shall be identified by part number.

B. Cast In Place Detectable/Tactile Warning Surface Tiles shall be delivered to location at building site for storage prior to installation.

1.7 PROJECT CONDITIONS

A. Maintain minimum temperature of 40°F in spaces to receive Cast In Place Detectable/Tactile Warning Surface Tiles for at least 24 hours prior to installation, during installation, and for not less than 24 hours after installation.

1.8 WARRANTY

A. Submit written warranty covering all materials and workmanship against defects or failures of any nature for the period indicated. Warranty shall include defective work, breakage, deformation, fading and loosening of tiles.

1. Period: Five years from the Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Vitrified Polymer Composite (VPC) Cast In Place Detectable/Tactile Warning Surface Tiles shall be an epoxy polymer composition with an ultra violet stabilized coating employing aluminum oxide particles in the truncated domes. The tile shall incorporate an in-line pattern of truncated domes measuring nominal 0.2" height, 0.9" base diameter, and 0.45" top diameter, spaced center-to-center 2.35" as measured on a diagonal and 1.67" as measured side by side.

1. Size: As indicated on the contract drawings.
2. Color: As selected by the Professional, and approved by the Department, using one color for the entire project.
3. Furnish materials according to PennDOT and ADA standards.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that substrate is level or to correct grade, is smooth, is capable of supporting tactile warning surface units and imposed loads, and is otherwise ready to receive Work of this Section. Prior to placement of the Cast In Place Detectable/Tactile Warning Surface Tile system, review manufacturer and contract drawings with the Contractor prior to the construction and refer to any and all discrepancies to the Professional.

3.2 INSTALLATION

A. The physical characteristics of the concrete shall be consistent with the contract specifications while maintaining a slump range of 4 – 7 to permit solid placement of the Cast In Place Detectable/Tactile Warning Surface Tile system. An overly wet mix will cause the tile to float. Under these conditions, suitable weights such as 2 concrete blocks or sandbags (25 lb.) shall be placed on each tile.

B. The concrete pouring and finishing operations require typical mason's tools; however, a 4' long level with electronic slope readout, 25 lb. weights, and a large non-marring rubber mallet are specific to the installation of the Cast In Place Detectable/Tactile Warning Surface Tile system. A vibrating unit should be fixed to a soft base such as wood, at least 1 foot square.

C. The factory-installed plastic sheeting must remain in place during the entire installation process to prevent the splashing of concrete onto the finished surface of the tile.

D. When preparing to set the tile, it is important that no concrete be removed in the area to accept the tile. It is imperative that the installation technique eliminates any air voids under the tile. Holes in the tile perimeter allow air to escape during the installation process. Concrete will flow through the large holes in each embedment flange on the underside of the tile. This will lock the tile solidly into the cured concrete.

E. The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to the tile placement. Immediately after finishing concrete, the electronic level should be used to check that the required slope is achieved. The tile shall be placed true and square to the curb edge in accordance with the contract drawings. The Cast In Place Detectable/Tactile Warning Surface Tiles shall be tamped (or vibrated) into the fresh concrete to ensure that the field level of the tile is flush to the adjacent concrete surface. The embedment process should not be accomplished by stepping on the tile as this may cause uneven setting which can result in air voids under the tile surface. The contract drawings indicate that the tile field level (base of truncated dome) is flush to

adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes.

F. While concrete is workable, a 3/8" radius edging tool shall be used to create a finished edge of concrete, then a steel trowel shall be used to finish the concrete around the tile's perimeter, flush to the field level of the tile.

G. During and after the tile installation and the concrete curing state, it is imperative that there is no walking, leaning or external forces placed on the tile that may rock the tile causing a void between the underside of tile and concrete.

H. Following tile placement, review installation tolerances to contract drawings and adjust tile before the concrete sets. Two suitable weights of 25 lb. each may be required to be placed on each tile as necessary to ensure solid contact of the underside of tile to concrete.

I. Following the concrete curing stage, protective plastic wrap is to be removed from the tile surface by cutting the plastic with a sharp knife, tight to the concrete/tile interface. If concrete bled under the plastic, a soft brass wire brush will clean the residue without damage to the tile surface.

3.3 CLEANING, PROTECTING, AND MAINTENANCE

A. Protect tiles against damage during construction period to comply with Tactile Tile manufacturer's specification.

B. Protect tiles against damage from rolling loads following installation by covering with plywood or hardwood.

C. Clean Tactile Tiles not more than four days prior to date scheduled for inspection intended to establish date of substantial completion in each area of project. Clean Tactile Tile by method specified by Tactile Tile manufacturer.

D. Comply with manufacturers maintenance manual for cleaning and maintaining tile surface and it is recommended to perform annual inspections for safety and tile integrity.

END OF SECTION

SECTION 32 3113
FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Fence framework, fabric, and accessories.
2. Excavation for post bases.
3. Concrete foundation for posts and center drop for gates.
4. Manual gates and related hardware.

1.3 REFERENCES

A. ASTM International:

1. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
3. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
4. ASTM A491 - Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
5. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
6. A1011/A1011M-07 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
7. ASTM B429/B429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
8. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
9. ASTM F567 - Standard Practice for Installation of Chain-Link Fence.
10.
11. ASTM F934 - Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.
12. ASTM F1043 - Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
13. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
14. ASTM F1184 - Standard Specification for Industrial and Commercial Horizontal Slide Gates.

B. Chain Link Fence Manufacturers Institute:

1. CLFMI - Product Manual.

1.4 SYSTEM DESCRIPTION

A. Fence Height: as indicated on Drawings.

B. Line Post Spacing: At intervals not exceeding 10 feet.

C. Chain Link Fence Post and Rail Strength: Conform to ASTM F1043 Heavy Industrial Fence quality.

1.5 SUBMITTALS

A. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components. Foundation design is to be designed by a licensed professional engineer in the Commonwealth of PA.

B. Product Data: Submit data on fabric, posts, accessories, fittings and hardware.

C. Submit Manufacturers brochure for fencing

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines.

B. Operation and Maintenance Data: Procedures for submittals.

1.7 QUALITY ASSURANCE

A. Supply material in accordance with CLFMI - Product Manual.

B. Perform installation in accordance with ASTM F567.

C. Perform Work in accordance with all applicable Federal, State, County, Local Municipal and PA DOT 2003 Publication 408 as amended/last revised standards.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section approved by manufacturer.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver fence fabric and accessories in packed cartons or firmly tied rolls.

B. Identify each package with manufacturer's name.

C. Store fence fabric and accessories in secure and dry place.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS (Chain Link)

A. All Chain Link Fence Materials and Components to be galvanized with painted black posts.

B. Materials and Components: Conform to CLFMI Product Manual.

C. Fabric Size: CLFMI Heavy Industrial service.

D. Intermediate Posts: Type I round.

E. Terminal, Corner, Rail, Brace, and Gate Posts: Type I round.

F. Slide Gate: as depicted on the drawings

2.2 ACCESSORIES

A. All Chain Link Fence accessories to be coated black

B. Caps: Galvanized pressed steel Malleable iron galvanized Aluminum alloy; sized to post diameter, set screw retainer.

C. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; galvanized steel.

D. Gate Hardware: as indicated on the drawings.

2.3 GATES

A. General:

1. Gate Types, Opening Widths and Directions of Operation: As indicated on Drawings.
2. Factory assemble gates.
3. Galvanized steel with black painted posts and accessories
4. Design gates for operation by one person.

B. Slide Gates:

1. Fabricate gates to permit complete slide opening without obstruction.

2. Gates Construction: ASTM F900 with welded corners. Use of corner fittings is not permitted.

2.4 PRIVACY SLATS – Not used

2.5 FINISHES

A. Components and Fabric: Galvanized Steet

B. Hardware: Galvanized to ASTM A153/A153M, 2.0 oz/sq ft coating.

C. Accessories: Black painted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install framework, fabric, accessories and gates in accordance with ASTM F567.

B. Set gate, posts plumb, in concrete footings with top of footing a minimum of 2 inches above 6 inches below finish grade. Slope top of concrete for water runoff.

C. Line Post Footing Depth Below Finish Grade: ASTM F567.

D. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567 feet.

E. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.

F. Install top rail through line post tops and splice with 6 inch long rail sleeves.

G. Install center and bottom brace rail on all sections.

H. Place fabric on outside of posts and rails.

I. Do not stretch fabric until concrete foundation has cured 28 days.

J. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

K. Position bottom of fabric 2 inches above finished grade.

L. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.

M. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

N. Install bottom tension wire stretched taut between terminal posts.

O. Install support arms sloped inward and attach barbed wire; tension and secure.

P. Support gates from gate posts. Do not attach hinged side of gate from building wall.

Q. Install gate with fabric to match fence. Install guide roller assembly on gate.

R. Provide concrete center drop to footing depth and drop rod retainers at ends of slide gate opening.

S. Install posts with 6 inches maximum clear opening from end posts to buildings, fences and other structures.

T. Excavate holes for posts to diameter and spacing indicated on Drawings without disturbing underlying materials.

U. Center and align posts. Place concrete around posts, and vibrate or tamp for consolidation. Verify vertical and top alignment of posts and make necessary corrections.

V. Extend concrete footings 1 inches above grade, and trowel, forming crown to shed water.

W. Allow footings to cure minimum 7 days before installing fabric and other materials attached to posts.

3.2 PRIVACY SLATS – Not Used

END OF SECTION

SECTION 32 3119
EXTERIOR STEEL SECURITY FENCES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.02 SECTION INCLUDES

A. Decorative steel fences.

1.03 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

B. Section 31 2316 - Excavation.

1.04 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

C. ASTM D822/D822M - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.

D. ASTM F2408 - Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

B. Shop Drawings:
   1. Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
   2. Foundation details, concrete design mix and reinforcing schedule for anti-ram barrier system.

C. Samples: Submit two samples of fence panels, mesh grilles , 12 inch by 12 inch in size illustrating construction and colored finish.

D. Manufacturer's Installation Instructions: Indicate installation requirements.

E. Manufacturer's Qualification Statement.

F. Installer's Qualification Statement.

G. Manufacturer's Warranty.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

B. Installer Qualifications: Experienced with type of construction involved and materials and techniques specified and approved by fence manufacturer.

1.07 DELIVERY, STORAGE AND HANDLING

A. Store materials in a manner to ensure proper ventilation and drainage. Protect against damage, weather, vandalism and theft.

1.08 WARRANTY

A. Provide twenty year manufacturer warranty for polyester finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Decorative Metal Fences and Gates:
   1. Ametco Manufacturing Corporation; Metro Design (Basis of Design): www.ametco.com.
   2. Substitutions: See Section 01 6000 - Product Requirements.

2.02 WELDED STEEL FENCE

A. Provide fence meeting requirements for Industrial class as defined by ASTM F2408.

B. Fence Panels: Fusion welded; up tp 12 feet high by 6.5 feet long.
   1. Panel Style: Bar and mesh grid.
      a. Main top bar: 1 inch by 3/16 inch.
      b. Vertical bar: 31/31 inch by 3/16 inch.
      c. Cross bar: 3/16 inch diameter.
      d. Mesh grid: 5 3/16 inch high by 2 7/16 inch wide.
      e. Coating: Hot dip galvanized in conforrmance with ASTM A123/A123M.
   2. Attach panels to posts with manufacturer's standard panel brackets.

C. Flexibility: Capable of following variable slope of up to 1:2.

D. Finish: Powder coated polyester enamel.
   1. Salt spray resistance:as tested by ASTM B117.
   2. Weatherability: Maintains gloss when tested by ASTM D822/D822M.

E. Color: Black.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Set fence posts in accordance with the manufacturer recommended spacing.

3.04 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch.

B. Maximum Offset From Indicated Position: 1 inch.

C. Minimum Distance from Property Line: 6 inches.

3.05 FIELD QUALITY CONTROL

A. Fence Height: Randomly measure fence height at three locations or at areas that appear out of compliance with design.

3.06 CLEANING

A. Leave immediate work area neat at end of work day.

B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.

C. Clean fence with mild household detergent and clean water rinse well.

D. Remove mortar from exposed posts and other fencing material using a 10 percent solution of muriatic acid followed immediately by several rinses with clean water.

E. Touch up scratched surfaces using materials recommended by manufacturer. Match touched-up paint color to factory-applied finish.

3.07 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair, or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 32 3223

SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Foundation.
2. Precast concrete modular units.
3. Foundation drain.
4. Free draining backfill.

B. Related Sections:
1. Section 03 3000 - Cast-In-Place Concrete
2. Section 31 2316 - Excavation
3. Section 31 2323 - Fill.
4. Section 32 0513 - Soils for Exterior Improvements
5. Section 32 1123 – Aggregate Base Course

1.3 UNIT PRICE – NOT USED

1.4 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
2. AASHTO T235 - Standard Specification for Bearing Capacity of Soil for Static Load on Spread Footings.

B. ASTM International:
1. ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
2. ASTM C1262 - Standard Test Method for Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units.
3. ASTM C1364 - Standard Specification for Architectural Cast Stone.
4. ASTM C1372 - Standard Specification for Dry-Cast Segmental Retaining Wall Units.

5. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
6. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
7. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
8. ASTM D1729 - Standard Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials.
9. ASTM D2244 - Standard test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates.
10. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
11. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
12. ASTM D4751 - Standard Test Method for Determining the Apparent Opening Size of a Geotextile.

C. National Concrete Masonry Association:

1. NCMA TEK 2-4A - Specification for Segmental Retaining Wall Units.
2. NCMA TR 127A - Design Manual for Segmental Retaining Walls.
3. NCMA TR 146 - Segmental Retaining Wall Installation Guide.

D. National Institute of Building Sciences:

1. NIBS - U. S. National CAD Standard.

E. Precast/Prestressed Concrete Institute:

1. PCI MNL-116S - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
2. PCI MNL-120 - PCI Design Handbook - Precast and Prestressed Concrete.
3. PCI MNL-123 - Design and Typical Details of Connections for Precast and Prestressed Concrete.

F. PennDOT Publication 408, current edition.

G. Geotechnical Exploration Report prepared by Maser Consulting, dated August 26, 2020.

1.5 SYSTEM DESCRIPTION

A. Retaining Wall System: Battered wall of stepped height formed from precast concrete modular facing and tieback units in configuration shown on drawings with foundation drain, backfill, and coping.

1.6 DESIGN REQUIREMENTS

A. General

1. Do not change indicated horizontal and vertical alignment of retaining walls, except as specified in this section.
2. Design retaining walls soil bearing in accordance with Sections 31 23 16 and 31 23 23.

B. Design footing wall facing and tieback units in accordance with specified NCMA requirements and the following:

1. External Stability Factor of Safety:

    a. Base Sliding: 1.5.
    b. Overturning: 1.5.
    c. Bearing Capacity: 2.0.
    d. Global Stability: 1.3.

2. Internal Stability Factor of Safety:

    a. Shear Capacity: 1.5.

3. Design Geometry:

    a. Provide length, height, and overall elevations of retaining wall as indicated on Drawings.
    b. Measure structure's design height, H, from top of footing to top of wall where ground surface intercepts wall facing.
    c. See Drawings for slopes above and below sections of segmental retaining wall.

4. Minimum Wall Embedment: Greater of height of a modular unit, 0.5 feet, or following minimum embedment required for slope below wall:

    a. Level: H/10.
    b. 3: 1 (18.4 degrees): H/10.
    c. 2: 1 (26.5 degrees): H/7.

5. Surcharges: Apply following surcharges to top of each design cross section based on the following uses above wall.
    a. Light Traffic: 100 lb/sq. ft.

6. Lateral Earth Pressure: Calculate lateral earth pressure to be resisted by self weight of retaining wall using Coulomb coefficient of earth pressure, Ka, times vertical stress at base of wall. Use coefficient of active earth pressure, Ka, from top to bottom of wall. Assume coefficient of active earth pressure, Ka, independent of external loads except sloping fills. For sloping fills, use coefficient of active earth pressure, Ka, appropriate for sloping condition, using Coulomb earth pressure in analysis.

7. Inclination of Failure Surface: Assume Coulomb failure surface passing through base of wall behind facing units up to ground surface at or above top of wall in design of wall.

8. Settlement Control: Professional will be responsible to determine if foundation soils will require special treatment to control total and differential settlement.

1.7 PERFORMANCE REQUIREMENTS

A. The wall designer is responsible for system design that considers allowable bearing pressure, external stability and internal stability, including global stability, total and differential settlement.

B. Design walls for locations and to overall dimensions indicated on Drawings utilizing specified backfill and foundation parameters.

C. Use no experimental or demonstration-type design concepts; or products, structures, or elements not preapproved by Professional, in design.

1.8 SUBMITTALS

A. Shop Drawings:

1. Manufactured Modular Wall - Modular Units and Support: Indicate type of wall, location, length, top elevation, bottom of footer elevation, cross-sections including backfill material type and limits, and quantities. Show complete layout plans and fabrication details for precast wall units, and step-by-step erection instructions. Indicate, unit locations, architectural details, support items, dimensions, openings, and relationship to adjacent materials , signed and sealed by professional engineer registered to work in the State of Pennsylvania.
2. Temporary Support System: Detail specific load bearing falsework, underpinning, needling, or shoring layout and support members appropriate for Project conditions.

B. Product Data: Submit data for cast modular units and other accessories. Color samples shall be provided for selection by the Professional.

C. Design Data: Submit the following signed and sealed by professional engineer licensed in state of Pennsylvania.

1. Calculations for manufactured modular wall including height of precast units, overall wall stability (internal stability and global stability) including sliding stability and overturning stability, and forces acting on wall and footing, precast facing and tieback units in accordance with design requirements.
2. Submit details and computations for any required temporary shoring, bracing and temporary support of excavation.

D. Submit documentation of experience in list of at least five projects of similar construction and scope which substantiate experience for system. Include brief description of each project and name and phone number of owner's representative knowledgeable in each listed project.

E. Test Reports: Indicate certified tests results for precast concrete at manufacturing facility, cast-in-place concrete in field, and granular backfill.

F. Manufacturer's Installation Instructions: Submit installation instructions including construction sequence and scheme and following:

1. Excavation and required bracing.
2. Placement of footing.
3. Placement of precast concrete facing units and tieback units.
4. Placement of drainage, backfill and geotextile.

1.9 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual elevation of undercut base, if any, and foundation elevation and position.

1.10 QUALITY ASSURANCE

A. Perform precast work in accordance with requirements of PCI MNL-116S, PCI MNL-123, PCI MNL-120.

B. Perform required manufactured modular retaining walls work in accordance with manufacturers requirements.

1.11 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing manufactured modular retaining wall systems with minimum five years' experience.

B. Installer: Company specializing in performing work of this section with minimum three years experience approved by manufacturer.

C. Design and construct manufactured modular retaining wall including temporary support under direct supervision of professional engineer experienced in design of this Work and licensed in State of Pennsylvania.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Check materials upon delivery to assure receipt of proper material. Inspect for damage. Replace damaged materials.

B. Handle, store and ship units to avoid chipping, cracking, and fracturing and to prevent contamination that may affect performance.

C. Protect materials from damage during storage and installation. Remove and replace damaged units.

1.13 ENVIRONMENTAL REQUIREMENTS

A. Do not install foundation when subgrade is wet or frozen.

1.14 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.15 COORDINATION

A. Coordinate work with wall penetrations, connection to storm water system, affected utility companies, and utility adjustments.

PART 2 - PRODUCTS

2.1 FOUNDATION MATERIALS

A. Coarse Aggregate: As specified in Section 32 0516,

B. Concrete: As specified in Section 03 3000

2.2 BACKFILL AND DRAINAGE SYSTEM

A. Aggregate:

1. Coarse Aggregate Backfill: ASTM D448, AASHTO Size No. 57 hard, durable, angular gravel, crushed gravel, or crushed stone, or combination of gravel, crushed gravel, or crushed stone, no slag.

B. Filter Fabric:

1. Geotextile Filter Fabric: AASHTO M288, non-biodegradable, non-woven, polyester filter fabric suitable of segregation of particulate materials.

C. Foundation Drain Pipe

1. Foundation Drain Pipe: SDR 35 polyvinyl chloride (PVC), perforated pipe

2.3 WALL SYSTEM MATERIALS

A. Modular Face and Tieback Units:

1. Product Description: ASTM C1372, precast solid concrete units, zero slump molded under high vibration and pressure, with textured exterior face, color to be selected by owner:

a. Standard units: Closed face containing off-set tongue and groove for self-battering, chamfered unit facing to create random block appearance and form exterior facia.
b. Coping units: Same as standard units without tongue
c. Tie-back Units: Manufacturer's standard geogrid reinforced unit as required for specified design conditions in accordance with shop drawings.

B. Compressive Strength: minimum 4500 psi at 28 days.

C. Freeze Thaw and Maximum Moisture Absorption Rate: ASTM C1262, 5 percent to ensure adequate freeze thaw protection.

2.4 FABRICATION

A. Visually inspect color differences between fabricated units and approved sample in accordance with ASTM D1729.

B. Install per manufacturers requirements.

C. Handle and erect concrete units carefully so as to avoid damage to units. Replace any members damaged to extent where their aesthetics or structural integrity is compromised.

2.5 ERECTION TOLERANCES

A. The following tolerances are maximum allowable deviation from indicated construction:

1. Vertical Control: plus or minus 1.25 inches over a 10 ft distance, plus or minus 3 inches total.
2. Horizontal Control: plus or minus 1.25 inches over a 10 ft distance, plus or minus 3 inches total.
3. Rotation: plus or minus 2 degrees from planned wall batter.
4. Bulging: 1.0 inch over a 10 ft distance.

2.6 FIELD QUALITY ASSURANCE

A. Compaction Testing: As specified in Section 31 2323.

B. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

C. Frequency of Compaction Testing: Two (2) for each lift.

2.7 MANUFACTURER'S FIELD SERVICES

A. Furnish manufacturer's representative at Project site to assist Contractor, and Professional until they are familiar with and confident in installation, and construction procedures.

B. Furnish monthly visits to Project site by company representative during wall construction.

END OF SECTION

SECTION 32 9113

SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Preparation of subsoil.
2. Soil testing.
3. Placing topsoil.

B. Related Sections:

1. Section 31 0000 – Earthwork
2. Section 31 2213 - Rough Grading: Rough grading of site.
3. Section 31 2316.13 - Trenching: Rough grading over cut.
4. Section 32 9119 - Landscape Grading: Preparation of subsoil and placement of topsoil in preparation for the Work of this section.
5. Section 32 9219 – Seeding.
6. Section 32 9300 - Plants.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 SUBMITTALS

A. Test Reports: Indicate topsoil nutrient and pH levels with recommended soil supplements and application rates.

B. Provide certification and test results of compost for landscape restoration to insure compliance with Conservation District requirements and Drawings.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with PennDOT Publication 408 standards and Drawings.

1.6 COORDINATION

A. See Division 01 requirements for coordination.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Topsoil: As specified in Section 31 0513 – Soils for Earthwork.

B. Compost: As specified in Section 31 0513 – Soils for Earthwork.

2.2 SOURCE QUALITY CONTROL

A. Provide recommendation for fertilizer and lime application rates for specified seed mix as result of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify prepared soil base is ready to receive the Work of this section.

3.2 PREPARATION OF SUBSOIL

A. Prepare sub-soil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated sub-soil.

C. Scarify subsoil to depth of 3 inches where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted sub-soil.

3.3 PLACING TOPSOIL

A. Spread topsoil to minimum depth of 4 inches over area to be seeded. Rake until smooth.

B. Place topsoil during dry weather and on dry unfrozen subgrade.

C. In areas specified for soil amendments, place in accordance with Section 31 2323 - Fill.

D. Remove vegetable matter and foreign non-organic material from topsoil while spreading.

E. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.

END OF SECTION

SECTION 32 9119
LANDSCAPE GRADING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Final grade topsoil for finish landscaping.

B. Related Sections:

1. Section 31 0000 - Earthwork
2. Section 31 2213 - Rough Grading: Site contouring.
3. Section 31 2316.13 - Trenching: Backfilling trenches.
4. Section 31 2323 - Fill: Backfilling at building areas.
5. Section 32 9219 – Seeding: Soil Supplements and Finish ground cover.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 SUBMITTALS

A. Materials Source: Submit name of imported materials source.

1.5 QUALITY ASSURANCE

A. Furnish each topsoil material from single source throughout the Work.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Topsoil: As specified in Section 31 0513 – Soils for Earthwork.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify building and trench backfilling have been inspected.

B. Verify substrate base has been contoured and compacted.

3.2 PREPARATION

A. Protect landscaping and other features remaining as final Work.

B. Protect existing structures, fences, sidewalks, utilities, paving, and curbs.

3.3 SUBSTRATE PREPARATION

A. Eliminate uneven areas and low spots.

B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove contaminated subsoil.

C. Scarify surface to depth of 3 inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.4 PLACING TOPSOIL

A. Place topsoil in areas where seeding, planting, is required. Place topsoil during dry weather.

B. Fine grade topsoil to eliminate rough or low areas. Maintain profiles and contour of subgrade.

C. Remove roots, weeds, rocks, and foreign material while spreading.

D. Manually spread topsoil close to plant material to prevent damage.

E. Place compost in accordance with Section 31 2323 – Fill.

F. Lightly compact placed topsoil.

G. Remove surplus subsoil and topsoil from site.

H. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.5 TOLERANCES

A. Top of Topsoil: Plus, or minus 1/2 inch.

3.6 PROTECTION OF INSTALLED WORK

A. Prohibit construction traffic over topsoil.

END OF SECTION

SECTION 32 9219
SEEDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Fertilizing.
2. Seeding.
3. Hydroseeding.
4. Mulching.
5. Maintenance.

B. Related Sections:

1. Section 31 2213 - Rough Grading: Rough grading of site.
2. Section 31 2317 - Trenching: Rough grading over cut.
3. Section 32 9113 - Soil Preparation
4. Section 32 9119 - Landscape Grading: Preparation of subsoil and placement of topsoil in preparation for the Work of this section.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCES

A. ASTM International:

1. ASTM C602 - Standard Specification for Agricultural Liming Materials.

B. PENNDOT PUBLICATION 408 standards

C. PA CHAPTER 102; PADEP Erosion and Sediment Pollution Control Program Manual

1.5 DEFINITIONS

A. Weeds: Vegetative species other than specified species to be established in given area.

1.6 SUBMITTALS

A. Product Data: Submit data for seed mix, fertilizer, and mulch, and other accessories.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include maintenance instructions, cutting method and maximum grass height;

1.8 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.

B. Perform Work in accordance with PennDOT Publication 408 standards

C. Perform Work in accordance with the PA CHAPTER 102; PADEP Erosion and Sediment Pollution Control Program Manual and E&S Plan

1.9 QUALIFICATIONS

A. Seed Supplier: Company specializing in manufacturing Products specified in this section with minimum three years experience.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.11 MAINTENANCE SERVICE

A. Maintain seeded areas immediately after placement until grass is well established and exhibits vigorous growing condition for two cuttings.

PART 2 - PRODUCTS

2.1 SEED MIXTURE

A. Furnish materials in accordance with PennDOT Publication 408 standards

B. Seed Mixture: As specified on the plans in accordance with Fayette County Conservation District standards

2.2 ACCESSORIES

A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.

B. Fertilizer: Commercial grade; recommended for grass; of proportion necessary to eliminate deficiencies of topsoil

C. Lime: ASTM C602, Class T agricultural limestone containing a minimum 80 percent calcium carbonate equivalent.

D. Water: Clean, fresh and free of substances or matter capable of inhibiting vigorous growth of grass.

2.3 SOURCE QUALITY CONTROL

A. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.

B. Provide recommendation for fertilizer and lime application rates for specified seed mix as result of testing.

C. Testing is not required when recent tests and certificates are available for imported topsoil. Submit these test results to testing laboratory. Indicate, by test results, information necessary to determine suitability.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify prepared soil base is ready to receive the Work of this section.

3.2 FERTILIZING

A. Apply lime at application rate recommended by soil analysis. Work lime into top 6 inches of soil.

B. Apply fertilizer at application rate recommended by soil analysis.

C. Apply after smooth raking of topsoil

D. Do not apply fertilizer at same time or with same machine used to apply seed.

E. Mix fertilizer thoroughly into upper 2 inches of topsoil.

F. Lightly water soil to aid dissipation of fertilizer. Irrigate top level of soil uniformly.

3.3 SEEDING

A. Apply seed at rate as specified on the plans evenly in two intersecting directions. Rake in lightly.

B. Do not seed areas in excess of that which can be mulched on same day.

C. Planting Season: Per Fayette County Conservation District regulations

D. Do not sow immediately following rain, when ground is too dry, or when winds are over 12 mph

E. Immediately following seeding and compacting, apply mulch to thickness of 1/8 inches. Maintain clear of shrubs and trees.

F. Apply water with fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

3.4 HYDROSEEDING

A. Apply fertilizer, mulch and seeded slurry with hydraulic seeder at rate specified by the Fayette County Conservation District

B. After application, apply water with fine spray immediately after each area has been hydroseeded. Saturate to 4 inches of soil and maintain moisture levels two to four inches.

3.5 SEED PROTECTION

A. Cover seeded slopes where grade is 3:1 or greater with erosion fabric. Roll fabric onto slopes without stretching or pulling.

B. Lay fabric smoothly on surface, bury top end of each section in 6-inch-deep excavated topsoil trench. Overlap edges and ends of adjacent rolls minimum 12 inches. Backfill trench and rake smooth, level with adjacent soil.

C. Secure outside edges and overlaps at 36-inch intervals with stakes.

D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

3.6 MAINTENANCE

A. Mow grass at regular intervals to maintain at maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at each mowing. Perform first mowing when seedlings are 40 percent higher than desired height.

B. Neatly trim edges and hand clip where necessary.

C. Immediately remove clippings after mowing and trimming. Do not let clippings lay in clumps.

D. Water to prevent grass and soil from drying out. Within lawn areas, provide temporary turf-watering equipment to keep turf uniformly moist to a depth of 4 inches. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate throughout maintenance period.

E. Control growth of weeds. Apply herbicides. Remedy damage resulting from improper use of herbicides.

F. Immediately reseed areas showing bare spots.

G. Repair washouts or gullies.

H. Protect seeded areas with warning signs during maintenance period.

END OF SECTION

SECTION 33 0516.13
PRECAST CONCRETE UTILITY STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section includes precast concrete utility structures:

1. Precast concrete utility structures.
2. Drainage system catch basins.
3. Drainage system inlets.
4. Drainage system junction boxes.
5. Drainage system sedimentation chambers.
6. Knock-out boxes.
7. Valve pits.
8. Pipe ends.
9. Frames and covers.
10. Access hatches.

B. Related Sections:

1. Section 03 3000 - Cast-in-Place Concrete: Concrete type for manhole and structure foundation slab construction.
2. Section 31 2316 - Excavation: Excavating for structures and foundation slabs.
3. Section 31 2323 - Fill: Backfilling after structure installation.
4. Section 33 3100 - Sanitary Utility Sewerage Piping: Piping connections to structures.
5. Section 33 4100 - Storm Utility Drainage Piping: Piping connections to structures.

1.3 UNIT PRICE – MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCE STANDARDS

A. PennDOT Publication 408, current edition.

B. PennDOT Publication 72M, RC Standards, current edition.

C. American Association of State Highway Transportation Officials:

1. AASHTO M306 - Drainage Structure Castings.
2. AASHTO S99-HB - Standard Specifications for Highway Bridges.

D. American Concrete Institute:

1. ACI 318 - Building Code Requirements for Structural Concrete.
2. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
3. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete.

E. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
3. ASTM A82/A82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
4. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5. ASTM A185/A185M - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
6. ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
7. ASTM A497/A497M - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
8. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
9. ASTM A706/A706M - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
10. ASTM A767/A767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
11. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
12. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
13. ASTM A996/A996M - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
14. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
15. ASTM C33 - Standard Specification for Concrete Aggregates.
16. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
17. ASTM C138/C138M - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
18. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.
19. ASTM C150 - Standard Specification for Portland Cement.
20. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
21. ASTM C192/C192M - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
22. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

23. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
24. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
25. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete.
26. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
27. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
28. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
29. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
30. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Section Precast Concrete Water and Wastewater Structures.
31. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
32. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
33. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
34. ASTM C989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
35. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
36. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
37. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test prior to Backfill.
38. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
39. ASTM C1433 - Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers.
40. ASTM C1504 - Standard Specification for Manufacture of Precast Reinforced Concrete Three-Sided Structures for Culverts, Storm Drains, and Sewers.

F. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.
2. AWS D1.4 - Structural Welding Code - Reinforcing Steel.

G. National Precast Concrete Association:

1. NPCA Quality Control Manual for Precast Plants.
2. NPCA Plant Certification Program.

H. SSPC: The Society for Protective Coatings:

1. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).

1.5 SUBMITTALS

A. Shop Drawings:

1. Indicate structure locations, elevations, sections, equipment supports, piping, conduit, sizes and elevations of penetrations.

1.6 QUALITY ASSURANCE

A. Obtain precast concrete utility structures from single source.

B. Perform structural design in accordance with ACI 318.

C. Perform Work in accordance with NPCA Quality Control Manual for Precast Plants.

D. Conform to the following for material and fabrication requirements:

1. Single Cell Box Culverts: ASTM C1433.
2. Multiple Cell Box Culverts.
3. Three Sided Structures: ASTM C1504.
4. Other Structures: ASTM C913.

E. Perform welding in accordance with the following:

1. Structural Steel: AWS D1.1.
2. Reinforcing Steel: AWS D1.4.

F. Perform Work in accordance with all applicable Federal, State, County, Local Municipal and PennDOT Publications 72M and 408, current editions.

1.7 QUALIFICATIONS

A. Manufacturer: Certified by NPCA Plant Certification Program prior to and during Work of this section.

1.8 DELIVERY, STORAGE AND HANDLING

A. Comply with precast concrete manufacturer's instructions for unloading, storing and moving precast structures. Lift structures from designated lifting points.

B. Do not deliver products until concrete has cured 5 days or attained minimum 75 percent of specified 28 day compressive strength.

C. Store precast concrete structures to prevent damage to Department's property or other public or private property. Repair property damaged from materials storage.

C. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Design structures for minimum loads conforming to ASTM C857 and ASTM C890.

2.2 PRECAST CONCRETE UTILITY STRUCTURES

A. Manufacturers to be selected from PennDOT Bulletin 15 ApprovedConstructionMaterials

B. Furnish materials in accordance with all applicable State, local and PennDOT Publications 72M and 408, current editions.

C. Precast Concrete Utility Structures: Reinforced precast concrete.

D. Foundation Slab: Cast-in-place Precast concrete of type specified in Section 03 3000, leveled top surface.

E. Any deviation from the materials shown on the Drawings requires submission of a stormwater analysis, using the same methodologies and programs as the design, to prove the equivalent material exceeds the materials on the Drawings as well as submissions to all affected reviewing agencies to modifications to their permits. Absent of this information, the contractor is to pay the Professional for the necessary calculations to prove the materials exceed the designed material as well as for any changes to permits.

2.3 CONCRETE MATERIALS

A. Cement: ASTM C150, Type I - Normal Portland type.

B. Fine and Coarse Aggregates: ASTM C33, except gradation requirements do not apply.

C. Water: Clean and not detrimental to concrete.

2.4 CONCRETE REINFORCEMENT

A. Reinforcing Steel: ASTM A615/A615M, 60 ksi yield grade, plain billet bars, epoxy coated finish.

B. Reinforcing Wire:

1. Plain Wire: ASTM A82/A82M; epoxy coated.
2. Deformed Wire: ASTM A496 epoxy coated.

C. Welded Steel Wire Fabric:

1. Plain Wire: ASTM A185/A185M; unfinished.
2. Deformed Wire: ASTM A497/A497M; unfinished.

D. Reinforcing Steel Finishes:

1. Galvanized Finish: ASTM A767/A767M, Class I.
2. Epoxy Coating Finish: ASTM A775/A775M.

E. Wire and Wire Fabric Finishes:

1. Epoxy Coated Finish: ASTM A884/A884M, Class A finish.

2.5 FRAMES AND COVERS

A. Manufacturers to be selected from PennDOT Bulletin 15 ApprovedConstructionMaterials

B. Furnish materials in accordance with all applicable State, local and PennDOT Publications 72M and 408, current editions.

2.6 ACCESSORIES

A. Membrane Curing Compound: ASTM C309 Type 1 Class B.

B. Steps: Formed aluminum rungs.

1. Diameter: 3/4 inch.
2. Width: 12 inches.
3. Spacing: 16 inches on center vertically. As indicated on Drawings, in accordance with PennDOT 72M Standards.

C. Inserted and Embedded Items:

1. Structural Steel Sections: ASTM A36/A36M; galvanized.

D. Joint Sealants and Joint Gaskets:

1. Gasket Joints for Circular Concrete Pipe: ASTM C443; standard rubber gaskets.
2. External Sealing Bands: ASTM C877; Type I rubber and mastic bands.
3. Preformed Joint Sealants for Concrete Pipe and Box Sections: ASTM C990.
4. Elastomeric Joint Sealants: ASTM C920; silicone; Grade NS, Class 25;

E. Pipe Entry Connectors: ASTM C923.

F. Grout:

1. Cement Grout: Portland cement, sand and water mixture with stiff consistency to suit intended purpose.

2. Non-Shrink Grout: ASTM C1107/C1107M; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days;

G. Bituminous Coating:

1. Manufacturers:
   a. Bitumastic
   b. Beazer East, Inc. .

H. Touch-Up Primer for Galvanized Surfaces: SSPC 20 Type II Organic.

2.7 CONCRETE MIX

A. Select proportions for normal weight concrete in accordance with ACI 318. and ACI 211.1.

B. Reinforced precast concrete in accordance with ASTM C478 with gaskets in accordance with ASTM C923

C. Admixtures: Include admixture types and quantities indicated in concrete mix designs approved through submittal process.
1. Do not use calcium chloride.

2.8 FABRICATION

A. Fabricate precast concrete utility structures in accordance with ACI 318. and NPCA Quality Control Manual for Precast Plants.

B. Fabricate precast concrete utility structures to size, configuration, knock out panels, and openings as indicated on Drawings.

C. Construct forms to provide uniform precast concrete units with consistent dimensions.

D. Clean forms after each use.

E. Install reinforcing by tying or welding to form rigid assemblies. Position reinforcing to maintain minimum 1/2 inch cover. Secure reinforcement to prevent displacement when placing concrete.

F. Position and secure embedded items to prevent displacement when placing concrete.

G. Deposit concrete in forms. Consolidate concrete without segregating aggregate.

H. Provide initial curing by retaining moisture using one of the following methods:

1. Cover with polyethylene sheets.
2. Cover with burlap or other absorptive material and keep continually moist.
3. Apply curing compound in accordance with manufacturer's instructions.

I. Provide final curing in accordance with manufacturer's standard.

J. Remove forms without damaging concrete.

2.9 CONCRETE FINISHES

A. Formed Surfaces Not Exposed to View: As formed.

B. Unformed Surfaces: Finish with vibrating screed or hand float.

1. Permitted: Color variations, minor indentations, chips, and spalls.
2. Not Permitted: Major imperfections, honeycomb, or other defects.

C. Exposed to View Finishes: Troweled light broom

2.10 SOURCE QUALITY CONTROL

A. Visually inspect completed precast structures for defects.

1. Repair defects affecting exposed to view surfaces to achieve uniform appearance.
2. Repair honeycomb by removing loose material and applying grout to produce smooth surface flush with adjacent surface.
3. Repair major defects only when permitted by Professional.

B. Make test results available to Professional upon request.

2.11 FINISHING - STEEL

A. Galvanizing: ASTM A123/A123M; hot dip galvanize after fabrication.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify items provided by other sections of Work are properly sized and located.

B. Verify correct size and elevation of excavation.

C. Verify subgrade and bedding is properly prepared, compacted and ready to receive Work of this section.

3.2 PREPARATION

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.

C. Inspect precast concrete structures immediately prior to placement in excavation to verify are internally clean and free from damage. Remove and replace damaged units.

3.3 INSTALLATION

A. Install underground precast utility structures in accordance with ASTM C891 and manufacturer specifications.

B. Lift precast concrete structures at lifting points designated by manufacturer.

C. When lowering structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.

D. Install precast concrete base to elevation and alignment indicated on Drawings.

E. Install cast-in-place concrete foundation slab in accordance with Section 03 3000, trowel top surface level.

F. Install precast concrete utility structures to elevation and alignment indicated on Drawings.

G. Assemble multi-section structures by lowering each section into excavation.

1. Clean joint surfaces.
2. Install watertight joint seals in accordance with manufacturer's instructions using gasket joints.

H. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with grout.

I. Connect pipe to structure and seal watertight. Cut pipe flush with interior of structure.

J. Grout base to achieve slope to exit piping. Trowel smooth. Contour as indicated on Drawings.

K. Paint interior with 2 coats of bituminous interior coating at rate of 120 square feet per gallon for each coat.

L. Set frame and cover and access hatch level without tipping, to elevations indicated on Drawings.

1. Set cover and access hatch 2 inches above finished grade for structures located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.

2. Connect drain from access hatch frame to storm drainage system.

M. Touch up damaged galvanized coatings.

N. Backfill excavations for structures in accordance with Section 31 2323.

O. Install Work in accordance with all applicable State, local and PennDOT Publications 72M and 408, current editions.

P. Follow inspection, maintenance, and repair information as listed on the Drawings.

3.4 FIELD QUALITY CONTROL

A. Sanitary Manhole testing:

(1) Vacuum test: Prior to testing manholes, thoroughly clean manhole and seal openings to the satisfaction of the Borough representative. Seal openings using properly sized plugs. Perform testing with manhole frames installed. The joint between the manhole and the manhole frame shall be included in the test.

(a) Perform vacuum testing in accordance with the testing equipment manufacturer's written instructions.

(b) Draw a vacuum of 10 inches of mercury and close the values.

(c) Consider manhole acceptable when vacuum does not drop below nine inches of mercury for the following manhole sizes and times:

[1] Four-foot diameter: 60 seconds.

[2] Five-foot diameter: 75 seconds.

[3] Six-foot diameter: 90 seconds.

(d) If a manhole fails to pass the vacuum test, repair or replace all defective material and/or workmanship and shall conduct such additional tests as required by the Borough's representative to demonstrate that the manhole meets the requirements. All materials and methods used to repair the manholes shall meet with the approval of the Borough. All costs associated with repairs and retesting of manholes shall be paid by the contractor.

(2) Pick hole access. Prior to final acceptance, all manhole cover concealed pick holes will be tested to assure that the pick holes are easily accessible and that the manhole cover can be readily lifted and removed. If pick holes are not readily accessible, the cover shall be replaced with another cover which meets this requirement.

END OF SECTION

SECTION 33 0517

PRECAST CONCRETE VALVE VAULTS AND METER BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Precast concrete vaults.

B. Related Requirements:

1. Section 31 0516 - Aggregates for Earthwork: Bedding fill type.
2. Section 33 1116 - Site Water Utility Distribution Piping: Execution requirements for piping Work as required by this Section.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT- NOT USED

1.4 REFERENCE STANDARDS

A. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
3. ASTM A536 - Standard Specification for Ductile Iron Castings.
4. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
5. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
6. ASTM C33 - Standard Specification for Concrete Aggregates.
7. ASTM C150 - Standard Specification for Portland Cement.
8. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.

10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
11. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
12. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
13. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
14. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3).
15. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
16. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

B. PennDOT Publication 408, current edition.

C. PennDOT Bulletin 15.

D. Local Utility Company Standards and Details.

1.5 COORDINATION

A. Coordinate Work with utilities within construction area.

1.6 PREINSTALLATION MEETINGS

A. See Division 01 requirements for preinstallation meeting.

1.7 SUBMITTALS

A. Product Data: Submit data on valve vaults, meter boxes, and access hatches.

B. Shop Drawings: Provide shop drawings prepared by a licensed professional engineer in the Commonwealth of Pennsylvania. Indicate plan, location, inverts of connecting piping, sump area, reinforcing steel, hardware, and openings.

C. Manufacturer's Certificate: Certify that precast concrete valve vaults and meter boxes meet or exceed ASTM standards and utility company specified requirements.

D. Manufacturer Instructions: Submit special procedures for precast concrete valve vaults and meter boxes installation.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F.Qualifications Statement: Submit qualifications for manufacturer.

1.8 CLOSEOUT SUBMITTALS

A. See Division 01 requirements for closeout procedures.

B. Project Record Documents: Record actual locations and inverts of buried pipe, components, and connections.

1.9 QUALITY ASSURANCE

A. Perform Work according to PennDOT and Utility Company standards.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Transport and handle precast concrete units with equipment designed to protect units from damage.

C. Storage:

1. Store precast concrete valve vaults and meter boxes according to manufacturer instructions.
2. Do not place concrete units in position to cause overstress, warping, or twisting.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Performance and Design Criteria:

1. Perform work according to PennDOT and Utility Company standards.

2.2 PRECAST CONCRETE VALVES AND METER BOXES

1. Furnish materials according to PennDOT and Utility Company standards.

B. Valve Vault and Meter Box Frames and Covers:

1. Furnish materials according to PennDOT and Utility Company standards.

C. Access Steps:

1. Steel reinforced copolymer polypropylene: ASTM A615, Grade 60, 1/2-inch reinforced rod.

2. Aluminum: ASTM B221 Alloy 6061-T6.

2.3 MATERIALS

A. Portland Cement:

1. ASTM C150, Type II.

B. Coarse Aggregates:

1. ASTM C33.
2. Graded 1 inch to No. 4 sieve.

C. Sand:

1. ASTM C33
2. Fineness Modulus: 2.35.

D. Water:

1. Potable.
2. Clean and free of injurious amounts of acids, alkalis, salts, organic materials, and substances incompatible with concrete or steel.

E. Air-Entraining Admixtures: ASTM C260.

F. Reinforcing Steel:

1. Deformed Bars: ASTM A615, Grade 60.
2. Welded Wire Fabric: ASTM A185.

G. Joint Sealant:

1. ASTM C990.

H. Bedding:

1. Aggregate Bedding Material: Structural Fill as specified in Section 31 0516 - Aggregates for Earthwork.

2.4 FABRICATION

A. Fabricate precast reinforced concrete structures according to ASTM C913, to dimensions indicated on Drawings, and to specified design criteria.

2.5 MIXES

A. Design concrete mix to produce required concrete strength, air-entrainment, watertight properties, and loading requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that piping connections, sizes, locations, and inverts are as indicated on Drawings.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Ream pipe ends and remove burrs.

C. Remove scale and dirt from components before assembly.

D. Establish invert elevations for each component in system.

E. Hand trim excavation to suit valve vaults and meter boxes; remove stones, roots, and other obstructions.

3.3 INSTALLATION

A. Tank and Bedding:

1. Excavate as specified in Section 31 2316 – Excavation for Work.
2. Hand trim excavation for accurate placement of vaults and meter boxes to elevations indicated.
3. Place bedding material level in one continuous layer not exceeding 6 inches compacted depth and compact to 95 percent maximum density.
4. Backfill around sides of vaults and meter boxes, tamp in place, and compact to 95 percent maximum density.
5. Maintain optimum moisture content of bedding material to attain required compaction density.
6. Install vaults and meter boxes and related components on bedding.

B. Installation Standards: Install Work according to PennDOT and Utility Company standards.

C. Connect piping.

3.4 FIELD QUALITY CONTROL

A. See Division 01 requirements for inspection, testing, adjusting, and balancing.

B. Request inspection by Professional prior to placing aggregate cover over piping.

C. When inspection indicate Work does not meet specified requirements, remove Work, replace, and retest.

END OF SECTION

SECTION 33 0517.10
SANITARY WETWELL AND VALVE/METER CHAMBER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section includes the construction of sanitary wetwell modifications and construction of a new valve/meter chamber in conformity with the lines, grades, dimensions, and details shown on the plans, or as ordered by the Engineer, and in accordance with the provisions of these specifications.

B. Related Requirements:

1. Section 03 3000 - Cast-in-Place Concrete: Concrete material requirements.
2. Section 31 0513 - Soils for Earthwork: Soil backfill from above pipe to finish grade.
3. Section 31 0516 - Aggregates for Earthwork: Aggregate for pipe bedding and cover.
4. Section 31 2317 - Trenching: Excavation, backfilling, compacting, and fill over underground pipe markers.
5. Section 31 2323 - Fill: Requirements for fill over underground pipe markers.
6. Section 33 3100 - Sanitary Utility Sewerage Piping: Connections to sanitary sewerage system.

1.3 MATERIALS

A. Precast Reinforced Concrete Wetwell/ Chamber Sections

Prefabricated Concrete Structures: Pre-cast concrete structures shall be constructed to the general lengths, widths and heights shown on the Contract Drawings and shall conform to the latest requirements of ASTM Designation C-478 (round structures) or C-913 (rectangular structures). Special attention shall be given to equipment clearances and/or control dimensions noted on the Drawings and/or elsewhere herein. The structures shall be designed to adequately and safely support all live and dead loads to which the structure will be subjected, and to withstand all conditions which may be encountered.

Design calculations shall verify that the structures have been designed to withstand the burial depth, groundwater hydrostatic pressures and seismic forces based on the information provided, and also the dead and live loads anticipated for the structure. The structure shall have adequate wall, floor, and rook thickness and steel reinforcement for the depth and conditions of burial shown of the Drawings. Design computations for uplift forces shall contain a minimum factor of safety of 1.15.

Each pre-cast module shall be provided with formed male and female joints formed entirely of concrete employing a round rubber gasket. The connection shall be self-centering and watertight upon assembly. All joint shall be mortared inside and outside.

The wetwell and valve/meter chamber structures shall be fabricated and cast at the Manufacturer's facility in full accordance with approved shop drawings.

Concrete: Concrete used in the manufacture of the various structural components of the pre-cast concrete structures shall meet the following requirements:
Cement shall be High Early Strength Portland Cement, Type III, conforming to ASTM C-150. Fine aggregate shall consist of washed natural sand. Coarse aggregate shall consist of ¾" well-graded crushed stone conforming to ASTM specification C-33. Air entrainment shall be 4.5% plus or minus 1%.

The concrete used for the structural components shall attain a minimum 7-day compressive strength of 4,000 psi.

Reinforcement: Reinforcing steel used in the manufacture of the various structural components of the pre-cast concrete components shall meet the following requirements:

Steel shall be new, epoxy coated billet steel, deformed steel bars conforming to ASTM A-615 (latest revision) Grade 60. Welded steel wire fabric reinforcing shall conform to ASTM A-185 (latest revision). Minimum cover of reinforcement shall be 2 inches.

Penetrations: All pipe wall penetrations shall be formed utilizing resilient rubber pipe connectors. Pipe wall penetrations formed utilizing wall sleeves with Link Seals ® shall be considered approved equal installations.

All surfaces and openings for pipe shall be smooth, sound, and free of spalling. Holes shall be accurately located. Flexible rubber manhole sleeves or boots will be required for PVC pipe. Sleeves or boots shall be mechanically clamped or cast into the manhole in accordance with the manufacturer's recommendations. They shall be made to fit around the pipe and to be clamped with stainless steel bands around entering and leaving pipes providing a watertight seal which will accommodate pipe movements up to 2" radially, or 22 degrees angularly in any direction. Rubber for sleeves or boots shall be a composition that is resistant to common ingredients of sewage, industrial waste, and oils.

Finish: The exterior walls and bottom of the wet well and valve chamber shall have a bituminous coating applied to all surfaces. The wet well and valve chamber shall have a white epoxy coating applied to all interior surfaces (see sub-section 3.01.D for coating specifications).

Rubber "O" Ring Gaskets: If precast manhole sections are used, rubber "O" ring gaskets for joints shall conform to the requirements for rubber gaskets, as specified under the latest ASTM Designation C-443, "Joints for Circular Sewer and Culvert Pipe, Using Rubber Gaskets".

Foundation: Foundation materials shall be Class I embedment material as specified under 31 0516 - Aggregates for Earthwork.

Concrete Grading Rings: Concrete grading rings, if used, shall conform to the latest requirements of ASTM Designation C-139 specification.

B. Prestressed Concrete Cylinder Pipe (PCCP) (Wetwell Extension Only)

Pre-stressed concrete cylinder pipe shall only be used for wetwell extension.

Pre-stressed concrete (lined) cylinder pipe shall meet all requirements of AWWA C 301.

Reference Standards

AWWA C301 – Prestressed Concrete Cylinder Pipe, Steel-Cylinder Type
AWWA Manual M9 - Concrete Pressure Pipe

All pre-stressed concrete cylinder fittings shall be furnished by reputable manufacturers with a minimum of ten years of experience in manufacturing pre-stressed concrete cylinder pipe fittings. The manufacturing plant shall have a current Lloyd's Register Audit Certification for the manufacture of Pre-stressed Concrete Cylinder Pipe. Additionally, the pipe manufacturer shall be a member of the American Concrete Pressure Pipe Association. The fittings shall be manufactured and installed in accordance with industry standards and methods and shall comply in all respects with requirements of these specifications and with the latest edition of all referenced standards and specifications.

Inspection of the pipe and fittings will be made by the Engineer upon delivery at the site. The pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements. Pipe rejected after delivery shall be marked for identification and shall be repaired or removed from the job at once unless otherwise approved by the Engineer.

Unless otherwise specified, the design materials and workmanship for pipe shall conform to the requirements of AWWA C301. Core and coating thickness for pipe shall be as specified in AWWA C301.

Pre-stressed concrete cylinder pipe fittings shall be manufactured by Hanson Pressure Pipe, Grand Prairie, TX or equal.

Fabrication:

1. Steel thickness of all adapter fittings shall be designed in accordance with Chapter 8 of the AWWA M9 Manual for Concrete Pressure Pipe. Adapter fittings shall be designed for the same conditions as the adjacent pipe.

2. Fabrication of the adapters shall be as per AWWA M9 Manual and the AWWA C301 Standard for the Manufacture of Pre-stressed Concrete Steel Cylinder Pipe.

3. Interior and exterior concrete/mortar coating shall be as per the AWWA C301 Standard.

4. Cement shall be Type II and shall be in accordance with ASTM C150.

5. Bell and spigot joint rings shall be steel, self-centering type, and otherwise specified in AWWA C301. Surfaces of the joint rings that will be exposed after fabrication is complete shall receive a zinc metalized coating of 4 mils thickness (0.004").

6. The rubber gaskets shall be in accordance with AWWA C301 and shall be designed and manufactured so that the completed joint will withstand an internal water

pressure in excess of the highest pressure to which the pipe will be subjected without showing any leakage by the gasket or displacement of it.

Joints: Gaskets shall conform to AWWA C 301. Joints shall be made up in accordance with the manufacturer's recommendations, and shall be properly cleaned and lubricated and prepared prior to making the joint. The gasket shall be verified properly positioned using a feeler gage supplied by the manufacturer after installation. Upon proper jointing, the joint shall be externally wrapped with special grout bands furnished by the pipe manufacturer and filled with grout to the full circumference of the joint. The internal joint shall be filled with mortar to the flush inside face of the pipe.

Interior Coating: Interior of pipe and fittings shall be shop coated with in accordance with ASTM D4263, Concrete Tank Surface Coatings. Prior to coating, the Contractor shall perform testing on every section of pipe to be installed in accordance with ASTM D4263 to verify that capillary moisture in the concrete is absent prior to coating.

Exterior Coating: An exterior pipe protective coating suitable for exposure to the soil and moisture conditions shall be applied to the pipe based on the evaluated soil conditions, and where required by the Authority. Acceptable coating shall be Carboline 300M Coal Tar Epoxy, or approved equal, applied in strict accordance with the manufacturer's written recommendations. The pipe may alternatively be wrapped with a polyethylene wrap of a suitable thickness.

C. Wet Well Access Cover

Furnish Aluminum Access covers, and frames as shown on the plans. The Access covers shall be manufactured from 1-1/2inch thick, mill finish extruded aluminum grating. The door panel shall be 1-1/2 inch Aluminum grating, reinforced as required to withstand a minimum live load of 300 Lbs. per square foot. The door shall open a minimum 90 degrees and lock with a stainless-steel hold open arm with aluminum release handle. The door shall be flush with the surrounding grating. The unit shall be made lockable with a non-corrosive locking device and a non-corrosive handle. The hinges and all fastening hardware shall be stainless steel. The access cover unit shall be guaranteed against defects in material or workmanship for a period of 10-years.

D. Valve Chamber Access Cover

Furnish access cover and frame with drain channel frame fabricated from ¼- inch thick one piece, mill finish. Extruded aluminum channel frame, incorporating a continuous concrete embed anchor. A 1 ½-inch drainage coupling shall be located in the front left corner of the channel frame. Door panels shall be ¼-inch aluminum diamond plate, reinforced to withstand a minimum live load of 300 Lbs. per square foot. Doors shall open 90 degrees and automatically lock with stainless steel hold open arms with aluminum release handles. Doors shall close flush with the frame. Hinges and all fastening hardware shall be stainless steel. Unit shall lock with a non-corrosive locking bar and non-corrosive handle. Stainless steel spring assist lift units shall be included. The access cover unit shall be guaranteed against defects in material or workmanship for a period of 10-years. The access cover shall be as shown on the contract drawings and allow for easy access to the valves and by-pass pumping connection located in the valve chamber.

E. Wetwell/Valve Chamber Ladder

Aluminum wetwell/chamber ladders shall be the safety type and of aluminum alloy conforming to the Aluminum Association Alloy Specification 6061-T6

The rail shall be 3/8" x 2 1/2" flat bar and shall be spaced 16" apart. The wall mounted standoffs shall be 3/8" x 2 1/2" flat bar and welded to the rails at a maximum of 60" on center. The standoffs shall be a minimum of 7" and manufactured to fit flush with the wall. 1 3/8" diameter slip resistant ribbed rungs shall be spaced 12" on center and shall be welded to the inside of each rail. All aluminum parts embedded in or in contact with concrete shall be coated with bitumastic paint. All anchors, inserts, bolts necessary for installation of chamber steps/ladder shall be 304 stainless steel. Ladders shall be equipped with "ladder up" safety extension posts as manufactured by Halliday Products, or approved equal.

F. Piping:

All piping located within the pumping station wet well and valve chamber shall be CLASS 52 Ductile Iron pipe with Ductile Iron fittings. All piping smaller than 3" in diameter shall be as specified on the plans.

All surfaces of pipes, valves and all other metal surfaces shall be clean, dry and free of grease before coating. The surfaces shall be evenly coated as specified.

PART 2 - PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 Concrete Wetwell/Chambers

A. Excavation and Dewatering

The Contractor shall excavate, dewater, and backfill in accordance with the Methods of Construction as specified under Section 31 2300, "Sanitary Utility Sewerage Piping", in order to install wetwell/chambers at locations and to the grades shown on the plans or as directed by the Engineer.

B. Foundation

Wetwell/Chambers shall be placed on a 12" thick foundation of Class I embedment material as specified under Section 31 0516 "Aggregates for Earthwork: Aggregates for backfill in trenches". The limit of excavation for this foundation shall be the outside dimensions of the wetwell/chamber plus 2'. Methods of construction shall be as specified in Section 31 2300, "Sanitary Utility Sewerage Piping".

C. Precast Wetwell/Chambers

Precast base sections shall be installed on a foundation as specified above and indicated in the details. The joint surfaces, gaskets, and gasket groove of the wetwell/chamber base shall be

wiped clean, be free of all dirt and grit, and liberally soaped before joining with a lubricant recommended by the manufacturer in preparation for receiving the riser, cone or slab top section. After snapping the gasket into the recess, tension shall be equalized by running a screwdriver shaft or other suitable tool around the joint under the gasket. The riser or cone section with gasket in place should then be lowered into the bell of the manhole base, taking care that no dirt gets into the joint or on the gasket. Additional riser or cone sections should be jointed in a similar manner. Wetwell/Chamber sections shall be set vertical, in true alignment, so that the access steps are aligned to form a continuous ladder.

All lift holes, if any exist, shall be plugged with rubber stoppers and filled with mortar in a manner to ensure a watertight repair. All manhole joints shall be mortared and troweled to a smooth surface on the inside and outside surfaces.

D. Exterior Finish

All exterior walls shall be painted in accordance with the manufacturer's instructions with two (2) coats of Targuard, 8 mils/coat as manufactured by MAB, Inc., or equal.

E. Interior Finish

All interior walls shall be painted in accordance with the manufacturer’s instructions with two (2) coats of Ponamid Epoxy (Sand 54 plus White 54), 6.0 mils/coat as manufactured by MAB, Inc. or equal.

F. Wetwell/Chamber Access Doors

All wetwell/chamber access doors shall be cast into the top slab. In no cases will the wetwell/chamber access door be field fitted to the precast chamber top slab. If a precast concrete chamber is used, the Contractor shall make all arrangements to have the access door cast into the top slab at no additional cost to the Owner

G. Watertight Work Required

Construction of wetwells/chambers, regardless of type, must be carried on in a manner to ensure watertight work. Any leaks in structures shall be repaired to the satisfaction of the Engineer, or the entire work shall be removed and rebuilt.

H. Backfilling

Backfilling shall conform to the methods specified in the Section 31 2300, "Sanitary Utility Sewerage Piping" section. As soon as practical after the pipe and manholes have been placed, the concrete bottom and wetwell/chamber walls have acquired a suitable degree of hardness, and all other work necessary has been accomplished, backfilling shall be complete to the surface. No broken concrete, blacktop, wood blocks, or other unsuitable materials will be placed against the

masonry structures when backfilling. Unequal soil pressures shall be avoided by placing the fill evenly around the structure to the surfaces. Machinery used for compaction will be of such type that it will not cause cracking or injury to the manhole structure.

I. Connection to Wetwells/Chambers

Ductile iron pipe (DIP) and/or PVC pipe shall be sealed at Wetwell/Chamber using watertight gasket cast-in the structure wall by manufacturer and where required non-shrink grout. Link Seals and non-shrink grout, or equal may be used only when specifically approved by the Engineer. All exterior concrete/ grout shall be coated with two (2) coats of Targuard, 8 mil/coat, as manufactured by MAB, Inc, as or equal.

3.2 Piping, Valves, and Appurtenances

A. Inspection

All valves shall be manually opened and closed prior to installation, and the interior of the valves if required shall be cleaned by the Contractor.

B. Installation

i) Valves shall be installed as nearly as possible in the positions indicated on the Drawings consistent with conveniences of operating the handwheel or wrench. All valves shall be carefully erected and supported in their respective positions free from all distortion and strain or appurtenances during handling and installation. All material shall be carefully inspected for defects in workmanship and material, all debris and foreign material cleaned out of valve openings and seats, all operating mechanisms operated to check their proper functioning, and all nuts and bolts checked for tightness. Valves shall be packed and adjusted prior to field tests and shall be left in good condition. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced at the Contractor's expense. Valves shall not be installed with stems below the horizontal.

ii) Valves shall be set plumb and supported adequately in conformity with instructions of the manufacturer. Valves mounted on the face of concrete shall be shimmed vertically and grouted in place. Valves in the control piping shall be installed so as to be easily accessible. All valves shall be painted to match color code of adjoining piping

iii) All valves, including buried valves, shall be installed in such a manner as to make it possible to remove bonnets or heads and gates or plugs without destruction of any surrounding installation(s) or work in place. All valves shall be installed so as to be completely accessible for operation and free from interference when operated.

iv) Valves shall be provided with extension stems where required for convenience of operation. Extension stems shall be provided for buried valves and elsewhere so that the operating wrench

does not exceed 8' in length. Buried valves shall be equipped with an extension stem terminated with standard 2" operating nut and shall be set truly plumb with valves boxes directly over the valves. After being correctly positioned for line and grade, the earth fill shall be carefully tamped around the valve box. Top of box shall be 3" above ground encased as indicated in the drawings. Valve box cover shall be painted the same color as required by color code for the pipe service.

v) Operators on extended bonnet, stems and support brackets shall be set so that the stems shall run smoothly in true alignment. Extended bonnet shall be anchored firmly to concrete. Distances from the centerlines of valves to the operating level shall be checked by the Contractor and adjusted if necessary to suit the actual conditions of installation.

C. Valve Testing

All valves shall be factory tested and hydrostatic pressure equal to twice the working pressures. The manufacturer shall furnish the Engineer with certified copies of the test reports. All valves shall operate smoothly and to the specifications during field tests.

D. Valve Identification Marks

All valves shall have the size of the opening, the name of the manufacturer and the working water pressure for which they are designed, cast in raised letters upon the body of the yoke. All operating floor stands and bench stands for valves and gates shall have the name of manufacturer and the part number cast in raised letters in a readily identifiable and prominent location.

END OF SECTION

SECTION 33 1116
SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings for site water line including domestic water line and fire water line.
2. Valves.
3. Positive displacement meters.
4. Backflow preventers.
5. Underground pipe markers.
6. Precast concrete vault.
7. Bedding and cover materials.

B. Related Sections:

1. Section 03 3000 - Cast-In-Place Concrete
2. Section 31 0513 - Soils for Earthwork: Soils for backfill in trenches.
3. Section 31 0516 - Aggregates for Earthwork: Aggregate for backfill in trenches.
4. Section 31 2316 - Excavation: Product and execution requirements for excavation and backfill required by this section.
5. Section 31 2316.13 - Trenching: Execution requirements for trenching required by this section.
6. Section 31 2323 - Fill: Requirements for backfill to be placed by this section.
7. Section 33 1300 - Disinfecting of Water Utility Distribution: Disinfection of site service utility water piping.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Society of Mechanical Engineers:

1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

C. American Society of Sanitary Engineering:

1. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent.
2. ASSE 1013 - Reduced Pressure Principle Backflow Preventers.

D. ASTM International:

1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
2. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
3. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
4. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
5. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
6. ASTM D2241 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
7. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
8. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
9. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
10. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

E. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

F. American Water Works Association:

1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
5. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
6. AWWA C502 - Dry-Barrel Fire Hydrants.
7. AWWA C504 - Rubber-Sealed Butterfly Valves.
8. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 in. (50 mm) Through 24 in. (600 mm) NPS.
9. AWWA C509 - Resilient-Seated Gate Valves for Water-Supply Service.
10. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
11. AWWA C606 - Grooved and Shouldered Joints.
12. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.

13. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
14. AWWA C702 - Cold-Water Meters - Compound Type.
15. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
16. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. through 3 in., for Water Service.
17. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

G. Underwriters Laboratories Inc.:

1. UL 246 - Hydrants for Fire - Protection Service.

H. Local Water Company standards and specifications

1.5 SUBMITTALS

A. Product Data: Submit data and manufacturers certifications on pipe materials, pipe fittings, valves and accessories.

1.6 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Perform Work in accordance with local utility company standards.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

B. Do not place materials on private property without written permission of the property owner.

PART 2 - PRODUCTS

2.1 WATER PIPING

A. Ductile Iron Pipe: AWWA C151:C104:C150; double cement-mortar lined and seal coated in accordance with AWWA C104

1. Fittings: AWWA C110 Ductile iron, standard thickness, pressure rating of 250 psi
2. Joints: AWWA C111, rubber gasket with rods.
3. Jackets: AWWA C105 polyethylene jacket.

B. Manufacturers: Manufacturers shall be approved by the utility company

2.2 GATE VALVES

A. Manufacturers: Manufacturers shall be approved by the utility company

B. Furnish materials in accordance with utility company standards.

2.3 UNDERGROUND PIPE MARKERS

A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.4 BEDDING AND COVER MATERIALS

A. Bedding: Coarse Aggregate Fill as specified in Section 31 0516 – Aggregates for Earthwork.

B. Cover: Coarse Aggregate Fill, as specified in Section 31 0516 – Aggregates for Earthwork.

C. Soil Backfill from Above Pipe to Finish Grade: Soil Type as specified in Section 31 0513 – Soils for Earthwork. Subsoil with no rocks over 6 inches in diameter, frozen earth or foreign matter.

2.5 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type specified in Section 03 3000 – Cast-in-Place Concrete as shown on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify building service connection and municipal utility water main size, location, and invert are as indicated on Drawings.

B. Coordinate work with the utility company.

3.2 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare pipe connections to equipment with flanges or unions.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 31 2316.13 - Trenching.

B. Form and place concrete for pipe thrust restraints at change of pipe direction. Place concrete to permit full access to pipe and pipe accessories. Provide thrust restraint bearing on subsoil.

C. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 6 inches compacted depth; compact to 95 percent.

D. Backfill around sides and to top of pipe in accordance with Section 31 2323 – Fill.

E. Maintain optimum moisture content of fill material to attain required compaction density.

F. Place fill material in accordance with Section 31 2323 - Fill.

3.4 INSTALLATION - PIPE

A. Maintain separation of water main from sewer and water piping in accordance with utility company code.

B. Install ductile iron piping and fittings to AWWA C600.

C. Route pipe in straight line.

D. Install pipe to allow for expansion and contraction without stressing pipe or joints.

E. Install access fittings to permit disinfection of water system performed under Section 33 1300 – Disinfecting of Water Utility Distribution

F. Form and place concrete for thrust restraints at each elbow or change of direction of pipe main.

G. Establish elevations of buried piping with not less than 4 ft of cover.

H. Install plastic ribbon tape continuous over top of pipe, buried 6inches below finish grade, above pipe line; coordinate with Section 31 2323 – Fill and Section 31 2316.13 – Trenching.

I. Backfill trench in accordance with Section 31 2323 – Fill.

J. Install Work in accordance with utility company standards.

3.5 INSTALLATION - VALVES AND HYDRANTS

A. Set valves on solid bearing compacted soil.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

C. Install Work in accordance with local fire department and utility company standards.

3.6 INSTALLATION - METERS

A. Install Work in accordance with utility company standards.

3.7 SERVICE CONNECTIONS

A. Install water service in accordance with utility company requirements.

B. Install water service to 5 feet of building. Connect to building water service. Refer to Division 22 specifications.

C. Install Work in accordance with utility company standards.

3.8 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Flush and disinfect system in accordance with Section 33 1300.

3.9 FIELD QUALITY CONTROL

A. Pressure test system in accordance with AWWA C600 and the following:

1. Test Pressure: Not less than 200 psi ([1380 kPa]) or 50 psi ([345 kPa]) in excess of maximum static pressure, whichever is greater.
2. Conduct hydrostatic test for at least two-hour duration.
3. Fill section to be tested with water slowly, expel air from piping at high points. Install corporation cocks at high points. Close air vents and corporation cocks after air is expelled. Raise pressure to specified test pressure.
4. Observe joints, fittings and valves under test. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage. Retest.
5. Correct visible deficiencies and continue testing at same test pressure for additional 2 hours to determine leakage rate. Maintain pressure within plus or minus 5.0 psig (34.4 kPa) of test pressure. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
6. Compute maximum allowable leakage by the following formula:

$L = (SD\sqrt{P})/C$
L = testing allowance, in gallons per hour (liters per hour)
S = length of pipe tested, in feet (meters)
D = nominal diameter of pipe, in inches (mm)
P = average test pressure during hydrostatic test, in psig (kPa)
C = 148,000 (794,797)
When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

7. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections and retest until leakage is within allowable limits. Correct visible leaks regardless of quantity of leakage.

B. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

END OF SECTION

SECTION 33 1300
DISINFECTING OF WATER UTILITY DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section includes disinfection of potable water distribution system; and testing and reporting results.

B. Related Sections:

1. Section 33 1116 - Site Water Utility Distribution Piping: Product and Execution requirements for installation, testing, of site domestic water distribution piping.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCES

A. American Water Works Association:
1. AWWA B300 - Hypochlorites.
2. AWWA B301 - Liquid Chlorine.
3. AWWA B302 - Ammonium Sulfate.
4. AWWA B303 - Sodium Chlorite.
5. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
6. AWWA C651 - Disinfecting Water Mains.

B. Local Utility Company Standards and Details.

1.5 SUBMITTALS

A. Product Data: Submit procedures, proposed chemicals, and treatment levels for review.

B. Test Reports: Indicate results comparative to specified requirements.

1.6 CLOSEOUT SUBMITTALS

A. Disinfection Report:

1. Type and form of disinfectant used.
2. Date and time of disinfectant injection start and time of completion.
3. Test locations.
4. Name of person collecting samples.

5. Initial and 24-hour disinfectant residuals in treated water in ppm for each outlet tested.
6. Date and time of flushing start and completion.
7. Disinfectant residual after flushing in ppm for each outlet tested.

B. Bacteriological Report:

1. Date issued, project name, and testing laboratory name, address, and telephone number.
2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.
5. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Certify water conforms, or fails to conform, to bacterial standards of the utility company

C. Water Quality Certificate: Certify water conforms to quality standards of the utility company, suitable for human consumption.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with AWWA C651.

B. Perform Work in accordance with utility company and DEP standards.

1.8 QUALIFICATIONS

A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this section with minimum three years experience.

B. Testing Firm: Company specializing in testing potable water systems, certified by State of Pennsylvania.

C. Submit bacteriologist's signature and authority associated with testing.

PART 2 - PRODUCTS

2.1 DISINFECTION CHEMICALS

A. Chemicals: AWWA B300, Hypochlorite (HTH or Percholoron)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify piping system has been cleaned, inspected, and pressure tested.

B. Perform scheduling and disinfecting activity with start-up, water pressure testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

3.2 INSTALLATION

A. Provide and attach required equipment to perform the Work of this section.

B. Perform disinfection of water distribution system and installation of system and pressure testing. Refer to Section 33 1116 – Site Water Utility Distribution Piping.

C. Inject treatment disinfectant into piping system.

D. Maintain disinfectant in system for 24 hours.

E. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.

F. Replace permanent system devices removed for disinfection.

3.3 FIELD QUALITY CONTROL

A. Disinfection, Flushing, and Sampling:

1. Disinfect pipeline installation in accordance with AWWA C651. Use of liquid chlorine is not permitted
2. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
3. Legally dispose of chlorinated water. When chlorinated discharge may cause damage to environment, apply neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.
4. After final flushing and before pipeline is connected to existing system, or placed in service, employ an approved independent testing laboratory to sample, test and certify water quality suitable for human consumption.

END OF SECTION

SECTION 33 3100
SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Sanitary sewage pipe.
2. Underground pipe markers.
3. Manholes.
4. Bedding and cover materials.

B. Related Sections:

1. Section 31 0513 - Soils for Earthwork: Soils for backfill in trenches.
2. Section 31 0516 - Aggregates for Earthwork: Aggregate for backfill in trenches.
3. Section 31 2316 - Excavation: Product and execution requirements for excavation and backfill required by this section.
4. Section 31 2316.13 - Trenching: Execution requirements for trenching required by this section.
5. Section 31 2323 - Fill: Requirements for backfill to be placed by this section.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT – NOT USED

1.4 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
2. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

5. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
6. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
7. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
8. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
9. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
10. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
11. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
12. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
13. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
14. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
15. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
16. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

C. PennDOT Publication 408, current edition

D. City of Uniontown Standards

E. Local Utility Company Standards and Details.

1.5 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.6 SUBMITTALS

A. Product Data: Submit data indicating pipe material, pipe accessories, and cleanouts.

1.7 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record location of pipe runs, connections, manholes, cleanouts, and invert elevations on as-built drawings.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.8 QUALITY ASSURANCE

A. Perform Work in accordance with municipal standards.

1.9 FIELD MEASUREMENTS

A. Verify field measurements and elevations are as indicated on drawings.

1.10 COORDINATION

A. Coordinate the Work with termination of sanitary sewer connection outside building, connection to municipal sewer utility service, and trenching.

PART 2 - PRODUCTS

2.1 SANITARY SEWAGE PIPE (Gravity Pipe)

A. Plastic Pipe: ASTM D3034, SDR 35, Poly (Vinyl Chloride) (PVC) material; inside nominal diameter as shown on plans, bell and spigot style rubber ring sealed gasket joint.
   1. Fittings: PVC.
   2. Joints: ASTM F477, elastomeric gaskets.

2.2 UNDERGROUND PIPE MARKERS

A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.3 MANHOLES

A. Manholes as specified in Section 33 0516.13 – Precast Concrete Utility Structures.

2.4 BEDDING AND COVER MATERIALS

A. Bedding: Fill Type as specified in Section 31 0516.13 – Precast Concrete Utility Structures..

B. Cover: Fill Type, as specified in Section 31 0516.13 – Precast Concrete Utility Structures.

C. Soil Backfill from Above Pipe to Finish Grade: Soil Type, as specified in Section 31 0513 – Soils for Earthwork. Subsoil with no rocks over 6 inches in diameter, frozen earth or foreign matter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work. Confirm all inverts of existing sanitary sewer mains and identify any utility line conflicts. Advise the Professional of any conflicts prior to installing any pipe.

B. Verify trench cut and excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.2 PREPARATION

A. Correct over excavation with coarse aggregate.

B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 31 2316.13 – Trenching and as shown on the plans.

B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 6 inches.

C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with ASTM D2321. Seal joints watertight.

B. Lay pipe to slope gradients noted on drawings; with maximum variation from indicated slope of 1/8 inch in 10 feet.

C. Install bedding at sides and over top of pipe to minimum compacted thickness of 12 inches.

D. Refer to Section 31 2316.13 - Trenching for backfilling and compacting requirements. Do not displace or damage pipe when compacting.

E. Connect to building sanitary sewer outlet and municipal sewer system

F. Install plastic ribbon tape continuous over top of pipe. Buried 6 inches below finish grade coordinate with Section 31 2323 – Fill and Section 31 2316.13 - Trenching.

G. Install site sanitary sewage system piping to 5 feet of building. Connect to building sanitary waste system. Refer to Division 22 specifications.

H. Install Work in accordance with municipal standards.

3.5 INSTALLATION - MANHOLES

A. Install Work in accordance with PennDOT Publication 408, utility company, and municipal standards.

3.6 FIELD QUALITY CONTROL

A. Perform leakage, deflection, and mandrel test on site sanitary sewage system in accordance with municipal standards.

(1) Air Test. The system shall be tested to ensure it will hold a uniform gauge pressure of 3 1/2 pounds per square inch (PSI) without introduction of additional air for a period of at least three minutes. The contractor shall provide the appropriate test tees if necessary and temporary plugs and all equipment necessary to conduct the test in the presence of the City Inspector. The plumber shall also conduct the test under the observation and inspection of the City Inspector.

B. Request inspection prior to and immediately after placing bedding.

C. When tests indicate Work does not meet specified requirements, remove work, replace and retest.

3.7 PROTECTION OF FINISHED WORK

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 33 3216.13

PACKAGED UTILITY WASTEWATER PUMPING STATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:

1. Sewage Grinder pumping units in conjunction with the Administration Building Precast Wetwell and the package submersible grinder pump station PumpMate.

B. Related Requirements:

1. Section 03 3000 - Cast-in-Place Concrete: Requirements for anti-flotation collar.
2. Section 31 0513 - Soils for Earthwork: Soil backfill from above pipe to finish grade.
3. Section 31 0516 - Aggregates for Earthwork: Basin bedding, ballast, and backfill materials.
4. Section 31 2316 - Excavation: Excavation requirements.
5. Section 31 2317 - Trenching: Excavation, backfilling, compacting, and fill over underground pipe markers.
6. Section 31 2323 - Fill: Backfilling requirements.
7. Section 33 3100 - Sanitary Utility Sewerage Piping: Connections to sanitary sewerage system.
8. Section 33 3400 – Sanitary Utility Sewerage Force Mains

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT-NOT USED

1.4 REFERENCE STANDARDS

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. ASTM International:

1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

C. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.5 COORDINATION

A. Coordinate Work of this Section with utilities within construction area.

1.6 SUBMITTALS

A. Product Data: Submit manufacturer information concerning materials of construction and fabrication.

B. Shop Drawings: Submit detailed dimensions for materials and equipment, including pump basins, pumps, piping, controls including wiring schematics, and accessories.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures, anchoring, and layout.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

G. Qualifications Statements:

1. Submit qualifications for manufacturer and installer.
2. Submit manufacturer's approval of installer.

1.7 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.8 QUALITY ASSURANCE

A. Perform Work according to City of Uniontown and all applicable standards.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Handling:

1. Handle materials to prevent damage to interior or exterior surfaces.
2. Prepare pumps and accessories for shipment in such a manner as to prevent entry of foreign matter into product body.

C. Storage:

1. Store materials according to manufacturer instructions.
2. Store products in areas protected from weather, moisture, or possible damage.
3. Do not store products directly on ground.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PUMPMATE ABOVE GRADE WET WELL MOUNTED SUBMERSIBLE PUMP CONTROL STATION

A. Description:

1. The contractor shall furnish and install one factory assembled, PumpMate, above grade, wet well mounted submersible pump control station as manufactured by USEMCO, Inc., Tomah, Wisconsin and represented by Reiner Pump Systems, Inc., Stanhope, NJ, or pre-approved equal. The station shall be complete with all needed equipment factory installed on fiberglass coated reinforced concrete base with fiberglass cover. The principal items of equipment shall include U.L certification for package pumping stations, internal piping, valves, control panel, heater, ventilation, and all internal wiring, all as shown on the plans and specified herein.

Where an "approved equal" clause is provided, it is intended that the "equal" material or equipment be approved in writing by the engineer at least 15 days prior to the time of bidding. "Approved equals" not submitted 15 days prior to the bid will not be considered.

To insure total quality control, the complete unit shall be designed, fabricated, assembled and tested in house by the station manufacturer.

All mechanical and electrical components that comprise the pump station shall be nonproprietary and available for purchase from vendors other than the pump station manufacturer.

B. System Coordination and Single Source Responsibility

1. The equipment provided shall have a completely integrated microprocessor based automatic control and monitoring system consisting of the required controller, power equipment, motor starters, level/flow and alarm monitoring equipment in a factory wired and tested assembly. The automatic control and alarm/monitoring system components shall be standard, catalogued, stocked products of the system supplier to assure one source responsibility, immediately available spare/replacement parts, proper system interconnections and reliable long-term operation.

C. Field Supervision

1. The services of a factory trained, qualified representative shall be provided to inspect the completed installation, make all adjustments necessary to place the system in trouble free operation and instruct the operating personnel in the proper care and operation of the equipment.

D. Guarantee

1. The manufacturer of the pump station shall guarantee for a period of one year from the date station is placed into operation or eighteen months from date of shipment, whichever occurs first, that the entire station and all equipment therein shall be free from defects in design, materials and workmanship. Normal use items, such as grease, light bulbs, mechanical seals, packing and belts are excluded.

E. Above Grade Equipment Chamber

1. The equipment chamber common base shall be reinforced concrete. The reinforced concrete shall conform to the pertinent requirements of AASHTO Specification Designation, M-199-89, similar to ASTM Specification Designation, C-478-85a.

The fiberglass cover will be gel coated inside and out and be of suitable thickness and density formulated to provide durability, abrasion resistance, and color fastness. The coating will also be impervious to sewage, grease, oil, gasoline, and other common chemicals. The exterior finish will consist of 20 to 25 mils of gel coat with an added UV

absorber. Fiberglass laminate will then be applied to the backside of the gel coat to an approximate thickness of 1/8". This laminate will be a 25% to 28% chop glass load by weight. The laminate will be rolled out to remove all air and then allowed to cure. Foam insulation board with an R-value of 7.5 and an aluminum laminate vapor barrier will then be applied and bonded into place. A light layer of laminate is chopped on top of the foam sheet and rolled out to remove air and allowed to cure. A cover coat of gel coat with a surfacing agent is then applied on the inside of the part and allowed to cure.

The exterior shall be a tan textured surface. Smooth and/or glossy exteriors will not be acceptable and will not be considered due to their appearance and reflectivity characteristics.

The cover will have access doors on two sides. All access doors shall be equipped with continuous hinges and tamperproof keyed latches. All hardware for the cover shall be tamperproof. The entire cover shall be removable in order to service the equipment in the pump station. Removal shall require no more than two maintenance personnel for removal without the use of lifting equipment.

The cover shall be provided with inlet and discharge louvers and a thermostatically controlled fan.

The equipment chamber shall be provided with a wall mounted commercial grade 1500-Watt electric heater suitable for 120-volt, single phase service. The heater shall be of the fan-forced type, complete with a baked enamel safety grill. The heater shall be hard-wired to the control panel. The heater shall be as manufactured by Berko, Qmark, Dayton or Engineer approved equal. The heater shall be controlled by a digital thermostat separate from the unit heater. If the heater has an integral thermostat, it shall be disabled or turned to the maximum setting. The digital thermostat shall have a PTC 1000 Ohm remote probe with 48" extension. It will have a 120 Volt input and a 16 amp, 250 VAC resistive output to the heater. The display shall be a 3-digit, ½" digits plus Fahrenheit sign and bright red LED.

Removable lifting eyes shall be placed about the perimeter of the equipment base to facilitate lifting and handling of the station.

An aluminum hatch located exterior to the equipment chamber shall be provided for access to the wet well. Steel hatches or access doors will not be acceptable. The aluminum frame shall be ¼" thick extruded aluminum having a continuous concrete anchor as a part of the one-piece extrusion. The access cover shall be of ¼" aluminum diamond plate, reinforced with stiffener bars as required. The cover shall be able to withstand the live load of 300 lbs. per square foot. The cover will have stainless steel hinges and be equipped with a lifting handle and a padlock locking post (padlock by others). The cover shall open to 90 degrees and lock automatically in that position by a stainless steel positive locking arm. The cover will have a full-length ¼" thick aluminum skirt that will be continuous from the frame to the bottom of the base. Hooks will be provided in the access hatch for pump lifting cables or chains.

A caution sign shall be attached to the access hatch. The sign shall read as follows:

Caution: Dangerous/Hazardous Gases

Level 2 Confined Space
Do not enter without proper
Equipment or supervision

F. Safety Grate

1. The aluminum access hatch shall include aluminum safety grates for fall protection. The grate will have stainless steel hinges and shall be able to withstand the live load of 300 lbs. per square foot. The grate shall open to 90 degrees and lock automatically in that position by a stainless steel positive locking arm.

   A jib crane socket shall be provided in the concrete base to facilitate pump removal.

G. Piping & Valves

1. The station sewage piping shall be class 53 ductile iron pipe that will extend down through the common base plate terminating in plain ends exterior to the pump chamber. The pipes shall be sealed where they protrude through the base plate with link seal to form a gas tight seal between the pump chamber and wet well. Each discharge line shall be fitted with a plug valve and check valve as specified herein and sized as shown on the plans. All mill scale, rust, weld flux and other foreign matter shall be removed from all steel surfaces by shot blasting to SSPC SP-10 specification for near-white blast cleaning. Surface irregularities shall be removed by grinding. The piping and control panel bracket surfaces shall receive a minimum of two coats of self-priming, hi-build epoxy coating. The coating material shall show excellent resistance to immersion in seawater as well as to splash or spillage of water, petroleum products or salt solutions. These surfaces shall receive two coats at a minimum of 3 mils per coat to a total of 6 mils dry. A paint touch-up kit shall be provided with the station for coating damaged areas. 2" piping to be galvanized and epoxy coated.

   Tapping ports will be installed into the piping assembly to allow for air release and accept gauges for pressure readings of the pumps.

   Plug valves of the non-lubricated type shall be furnished and sized as shown on the plans. The valve body shall be of high quality cast iron construction with a welded nickel seat. The valves shall be furnished with permanently lubricated, corrosion resistant bearing surfaces in the upper and lower journals to withstand full rated bearing loads and to provide long life in sewage service. Valves shall provide a leak tight seal against full rated pressure in both directions. One handle for valve operation will be provided with the station. 2" valves shall be bronze or cast iron.

   Swing check valves, sized as shown on the plans shall be installed in the discharge piping. The valve shall permit flow in one direction only and close tightly without slamming when the discharge pressure exceeds the inlet pressure. The valve shall be provided with an outside lever and spring to accomplish quicker closing and to minimize slamming when rapid flow reversal is encountered. The valve in the full open position shall permit full flow

through the valve equal to the nominal pipe diameter. The valve body shall be of high quality cast iron construction and bronze fitted, capable of vertical installation. Wafer check valves will not be permitted. 2" valves shall be bronze or cast iron.

H. Discharge Pressure Gauge

1. A pressure gauges shall be provided to indicate discharge pressure. The gauges shall have 4-1/2" minimum diameter face with molded black phenolic case, turret type with snap ring face mounting. The gauge internal construction shall include phosphor bronze bourbon tube with bronze movement. Gauges shall have 1/4" N.P.T. bottom connections and provided with a brass needle isolation valve and vent cock.

I. Air Release Valve

1. An air release valve shall be provided in the discharge manifold to discharge trapped air back to the wetwell. The air release connection shall also include a quarter turn ball valve for isolation. The valve will be installed with schedule 40 galvanized, threaded pipes. The valve shall have the following features:

   - Cast Iron body and cover
   - Replaceable resilient seats
   - 175 PSI working pressure
   - Stainless steel float and trim
   - 3/4" NPT inlet
   - 1/2" NPT outlet

J. Emergency Pump Connection

1. The pump discharge piping shall be provided with a 2'' male cam lock emergency pump connection with isolation plug valve and dust cap sized as shown on drawing. Access to the cam lock fitting shall be from outside of PumpMate enclosure.

K. Wiring

1. All wiring shall be minimum 460-volt (UL) type MTW or AWM and have a current carrying capacity of not less than 125% of the full load current.

   The conductors shall be in complete conformity with the National Electric Code, state, local and NEMA electrical standards.

   To ensure the safety of all personnel working with this equipment, as well as providing a simple
   means of tracing wires when troubleshooting, all wiring shall be color coded in strict accordance with the wiring diagrams furnished by the equipment supplier.

   An isolation plate shall be provided for pump and float cord entry into the wetwell. The plate shall be drilled and tapped to accept cord grips that are rated for this service. The plate will

be gasketed and installed with a sealant to insure a gas tight fit

L. Power Supply and Metering

1. The incoming service shall be 460 volts, 3 phase, 3 wire, 60 cycle. All metering shall be done ahead of the main disconnect and control panel. The contractor in accordance with local power company requirements shall install the meter.

M. Control Panel

1. The control panel shall be constructed in compliance with Underwriter's Laboratories Industrial Control Panels listing and follow-up service; utilizing UL listed recognized components where applicable. The control panel shall bear a UL 698A serialized label.

   The described equipment shall be housed in a NEMA 1 stainless steel enclosure. The enclosure shall be approximately 36" high and 10" deep. The enclosure shall be constructed of not less than 14-gauge stainless steel.

   All major components and sub-assemblies shall be identified as to function with laminated, engraved Bakelite nameplates or similar approved means.

   The control shall operate two 7.5 HP submersible motors specified elsewhere on a pump down mode, and include items as specified hereinafter.

   An incoming main power distribution block shall be provided as the main connection point for the control panel.

   A thermal magnetic circuit breaker shall be supplied as branch circuit protection for each pump motor. The circuit breaker must have a minimum ampere interrupting capacity of (10,000-240 volt - 14,000-480 volt) symmetrical RMS amps. The circuit breaker shall be operable through the operator's door of the enclosure.

   The circuit breaker shall be properly sized to protect the control circuit conductors, motor starter and the motor against over current due to short circuit or grounds.

   A NEMA rated full voltage non-reversing motor starter with manual reset, ambient compensated, 3 phase thermal overload relay shall be provided for each of the pumps.

   A lightning arrestor shall be supplied in the control and connected to each line of the incoming side of the power input terminals. The arrestor shall protect the control against damage due to lightning strikes on the incoming power line.

   A solid state, phase sequence/failure and under voltage release relay shall be provided when a three phase service is supplied, to ensure additional running protection for the pump motors. The relay shall be complete with an LED to indicate proper phase sequence, all phases in operation and voltage within limits. The relay shall also include an adjustable voltage monitor, be UL and CSA certified and be complete with automatic reset feature.

As part of the stations control panel, an electrical distribution center consisting of thermal magnetic circuit breakers with a minimum capacity of 15 amps shall be provided for each branch circuit including the following:

Control
Blower
Heater
Convenience Receptacles

The circuit breakers shall indicate when the circuit is open and shall have means provided for manual switching. All breakers shall be labeled as to function with permanently attached phenolic nameplates

An inner door mounted ground fault interrupter (GFI) type convenience receptacle rated at 15 amperes shall be supplied for the operating of trouble lights, drill, etc. It shall be protected by a separate 15 ampere trip rated circuit breaker.

A five KVA transformer will be provided if 120 VAC cannot be derived from the incoming service.

N. USEMCO "SENTRY" Pump Controller

1. The control system shall utilize standard "off the shelf" equipment. Job specific, "one-of-a-kind" customized software and hardware components will not be accepted. A standard system is defined, as one, which has published literature, is available at time of bid, with fully tested hardware and software, such that no development must be done beyond system configuration.

   The equipment shall be protected from transient voltages and surges induced into the signal lines. The contractor shall provide a permanent earth ground connection to the panel ground lug in order to insure proper operation of transient protectors.

   A microprocessor-based automatic pump and alarm control system shall be provided for each pumping station, incorporating an industrial-grade, 16-bit CMOS microcomputer and associated element suitable for achieving performance as hereinafter described. The controller will incorporate the following:

   Internal diagnostics
   Real time clock calendar
   Floating point math
   Battery back up
   Non-propriétaire RTU communication
   (4) PID loops

   The system shall incorporate UL 508 Industrial Control Panel approved elements as required of all components of these project panels and be furnished with all necessary hardware and software to accomplish level-responsive pump and alarm operation with software specifically suited to this project.

All of the discrete I/O circuitry of the computer-based system shall be built to the IEEE 472 (1974) Surge Withstand Capability Standards. The automatic pump and alarm control system computer shall be the standard product of the control system manufacturer and specifically suited for this type of industrial control panel service. All job connections shall be a UL recognized clamp type barriered screw terminals accepting up to two AWG 14 conductors per terminal.

The constant speed drive equipment shall be programmed to respond to variations in the wetwell in a manner wherein the hydraulic requirement will be accommodated in the pumping program using simple menu-related operator interface routines.

Upon power-up, the Controller shall go through a timing routine, which allows the analog signal and display to stabilize before any control, or alarm outputs are enabled. After the stabilization period, the control circuits of the Controller shall be sequentially enabled on a time-step arrangement.

In addition to the time delay upon power-up, the differential-level control circuits shall each be forced to an off condition upon power up so that a level excursion will need to go past their turn-on elevation for them to operate.

An alternator shall operate the pumps in a First-on/First-off (FOFO) sequence and can be configured to sequence the pumps every start, every 24 hours, on the lowest run time or manually.

The alternator shall be capable of accepting pump failure and/or advance inputs and shall automatically transfer to the next pump sequence when failure condition input is sensed.

The alternator shall provide automatic transposing of the operating sequence of the control relays for the pumps on successive starts. The FOFO alternator sequencing shall operate such that the next load turned on is always the one that has had the longest opportunity to rest since its last operation.

It is the specific intention of this functional requirement that a standard programmable logic controller will be employed with features as herein described and be a fully integrated assembly. That is, the furnishing of similar functions using a proprietary controller with custom software, a multiplicity of setpoints, modules or extensive relay-timer logic to accomplish control sequences, etc., is specifically precluded by this specification and will not be acceptable.

Microprocessor based, programmable controller and operator interface shall provide all of the above controls and operations. A redundant back up float system shall be incorporated into the controller along with programmable automatic operation.

The automatic pump and alarm control shall employ an operator interface having a 240 x 80 pixel STN monochrome liquid crystal display. The operator interface shall have an IEC standard IP65F sealed housing. The display shall be rated for 50,000 hours and include an adjustable sleep mode to increase life. The unit supports four levels of password protection.

A Configuration and Operations Manual will be included for the pump controller. The Manual shall include the following information as a minimum:

-How to view and change between the various displays
-How to configure the controller
-How to display alarms
-How to display statuses
-Analog control setpoint adjustment
-Analog alarm setpoint adjustment
-How to view and reset pump run times
-How to view and reset pump start counters
-Security Password usage
-An example of programming values
-Adjustment of the real-time calendar/clock
-A listing of values programmed at the factory
-A worksheet for entering the values programmed in the field

The intent of the specification is that a standard controller be provided, with standard documentation. A custom written Description of Operation is not acceptable.

The pump controller operates on a 4-20mA input via a submersible transducer, ultrasonic transmitter or bubbler transmitter and shall be capable of being configured at the factory or jobsite to perform operating functions as described below. All configurations are password protected and shall be provided as a minimum as follows:

-Simplex/Duplex Pump operation
-Clock hours (0-23) and minutes (0-59).
-Calendar day of week (0-6 for Monday - Sunday).
-Wetwell transducer rating (1.0-15.0 PSI).
-Wetwell cross sectional area for Flow Monitor (up to 32,767 square inches)
-Lag pump disable for non-additive systems
-On board or Redundant float back up with weekly test feature
-Selectable pump fault for Low oil, Bearing overtemp or Check valve limit switch

The pump controller will include the field adjustable delay timers. All timer settings are password protected and shall be provided as follows:

-Pump 1 start fail delay (0-99 seconds).
-Pump 2-start fail delay (0-99 seconds).
-Lead pump start delay (0-99 seconds).
-Lag pump start delay (0-99 seconds).
-Lead pump stop delay (0-99 seconds).
-Lag pump stop delay (0-99 seconds).
-Delay between calls (0.1-9.9 minutes).
-Back up float pump down timer (1-5 minutes)
-Back up float lag call timer (0-99 seconds)

The pump controller will include the field adjustable setpoints. Setpoints are password

protected and provided as follows:

-Lead pump start
-Lead pump stop
-Lag pump start
-Lag pump stop
-High Level Alarm.
-Low Level Alarm.
-Back up high float

Provide menu driven screen displays for the following:

-Wetwell Level
-Pump Run time values scaled to hours and tenths.
-Pump Start counters
-Flow Rates
-Pumping Rates
-Alarm Messages

The controller can be configured to accept up to three back up floats (High, Lead, and Low) to be used in the unlikely situation that the transducer would fail. It also can be configured to perform a weekly test on the system to insure back up is operational. During the test, the alarms will be inhibited. The controller will continue to monitor the transducer input and if the high float setpoint is exceeded without the backup system calling a pump to run, a Backup Float Test Fail alarm message will be initiated, and the controller will return to normal operation. The controller shall be capable of being configured to operate the pumps and alarm on the backup floats as follows:

Single float operation (High Level)
When the high float is activated, the controller will call the lead pump and signal the alarm. If the float does not deactivate in a predetermined adjustable time, the lag pump will also start. When the low float is deactivated, the pump(s) will be turned off. The alarm will remain on until manually reset.

Two float operation (High and Low Level)
When the high float is activated, the controller will call the lead pump and signal the alarm. If the float does not deactivate in a predetermined adjustable time the lag pump will also start. When the low float is deactivated, the pump(s) will be turned off. The alarm will remain on until manually reset.

Three float operation (High Level, Lead and Low Level)
When the high float is activated, the controller will call the lead pump and signal the alarm. If the float does not deactivate in a predetermined adjustable time the lag pump will also start. When the low float is deactivated, the pump(s) will be turned off. Each subsequent activation of the lead on float will turn the lead pump on and subsequent activation of the high float will turn the lag pump on. The alarm will remain on until manually reset.

O. Weatherproof Alarm Light

1. A weatherproof high water, alarm light assembly including a high impact resistant lexan red lens and wire guard with mounting bracket shall be included, for enclosure or remote mounting.

P. Weatherproof Alarm Horn

1. A weatherproof high water audible alarm horn shall be provided. The horn will be side mounted to the enclosure, or provided for remote mounting, and shall operate on 115 VAC with a typical 95 DB output. An alarm silence push button shall be included and mounted on the operator's door.

Q. Low Temperature Alarm

1. A thermostat will be provided to alarm personnel that the temperature inside the PumpMate fiberglass enclosure has dropped to a temperature that could freeze piping and damage equipment. The thermostat shall have a SPDT contact rated for 10 amperes at 120 VAC.

R. Alarm Dialer

1. Upon closure of a contact, the dialer will call a pre-determined telephone number called is busy or the dialer is not acknowledged, the dialer will continuously dial up to eight (8) telephone numbers in succession until the dialer is acknowledged.

Alarm conditions monitored are as follows;

-Low Level Alarm
-Pump 1 and 2 Failure
-High Level Alarm
-Transducer Fail
-Low Temperature

Features shall include:

- Gelled electrolyte battery with charger
- 120 VAC, 60-hertz input
- Standard RJ-11 modular telephone connection
- Dial up to (8) numbers, up to 32 digits each
- Keypad for local programming and status checks
- Unit can be called from any phone for status
- Programmable security code access

S. Submersible Wetwell Level Sensing Transducer

1. A submersible level transducer shall sense the liquid level of the wetwell. The transducer shall be a 2-wire type to operate from a supply voltage of 10.5 to 24 VDC instrumentation signal in direct proportion to the measured level excursion over a factory-calibrated range of zero to 11.5 feet of water. It shall be of the head-pressure sensing type, suitable for continuous submergence and operation and shall be installed in accordance with manufacturer's instructions. The bottom diaphragm face (2½" diameter minimum) of the sensor shall be installed 6 inches above the floor at elevation indicated on electrical plan___.

   The transducer shall incorporate a diffused silicon semiconductor transducer element to convert the sensed pressure to a corresponding electrical value. The sensed media shall exert its pressure against the diaphragm, which flexes minutely to vary the proximity between an internal ceramic diaphragm created between the two surfaces. A stable, hybrid, operational amplifier assembly shall be incorporated in the transducer to excite and demodulate the sensing mechanism. The transducer shall incorporate laser trimmed, temperature compensation and high quality components and construction to provide a precise, reliable, stable output signal directly proportional to the sensed pressure over a factory-calibrated range.

   The pump controller shall connect to the submersible transducer through an intrinsically safe module. The module shall provide an intrinsically safe interface for the sensor located in a hazardous area rated Class 1 Groups C and D. The intrinsic safety barrier shall be UL listed.

T. Wetwell Level Sensing Float Switches

1. Provide three back up float(s) for redundant control and alarm. The float(s) shall be non-mercury and have a molded polypropylene body, internal redundant polyurethane foam floatation, potted switch/cable connections and fine stranded AWG #18 cable with heavy-duty synthetic rubber jacket in lengths as required to run unspliced to the control panel.

   The contractor shall furnish, install and wire the float switches as shown on the drawings. The float switches shall be individually suspended in the wetwell with weight kits. The float switch cables shall be suspended from a cable rack mounted to the top of the wetwell.

   The pump level controller shall connect to the float switch level sensors through an intrinsically safe module. The module shall provide an intrinsically safe interface for the sensors located in a hazardous area rated Class 1 Groups C and D. The module shall contain an LED indicator providing visible indication of sensor actuation. The intrinsic safety barrier shall be UL listed.

U. Inspection and Test

1. Prior to assembly, all station components shall be inspected for quality and tested for proper function and freedom from defects. Upon completion, the station shall be connected to a test tank and an operational test performed under simulated field conditions while a final inspection is conducted. Any deficiencies or irregularities shall

be corrected at the factory. Automatic controls shall be adjusted to approximate job requirements.

V. Initial Operation

1. After the installation is complete, the manufacturer shall provide the services of a factory trained representative for a maximum period of one day to perform initial start-up of the pump station and to instruct the owner's operating personnel in the operation and maintenance of the equipment. Two (2) copies of O and M manuals will be supplied to the owner prior to initial operation.

2.2 SULZER ABS SUBMERSIBLE XFP 100E PE 56/4 3 INCH PUMP, 2 POLE, 3 PHASE, PE1

A. SCOPE

1. Furnish, Two ABS Model XFP 100E PE 56/4 Submersible wastewater pump(s). The pump(s) shall be capable of delivering 211.2 U.S. GPM at a total dynamic head of 49.86 feet. An additional point on the same curve shall be 70 U.S. GPM at a total dynamic head of 105 feet. Shut off head shall be 160 feet (minimum). The motor shall be an integral part of the pump unit. The motor shall be 7.5 HP connected for operation on a 460 volt, 3 phase, 60 hertz electrical supply service. Pumps are intended for wet pit installation and shall be supplied with a Guiderail Rail Assembly to support the pump. Each pump unit shall be fitted with a SS Grab Link Assembly, 15 feet long for lifting the pump. The working load rating of the lifting system shall be a minimum of 50% greater than the pump weight. Each pump motor shall be equipped with 49 feet of power and control cable sized in accordance with NEC and CSA standards.

B. DESIGN PARAMETERS

1. Primary design point: 100 GPM @ 25’ TDH with a minimum efficiency of 27%
Secondary design point: 195 GPM @ 45’ TDH with a minimum efficiency of 32%
Minimum shutoff head of 160’
Maximum motor HP (non-overloading throughout curve) of 7.55 HP with a full load amp of 9.9 @ 460 volt at a max speed of 1757 rpm.
Minimum motor efficiency of 91.7% at full load, 91% at 75% load, and 88.4% at 50% load.
Pump Model: Sulzer ABS Model Submersible XFP 100E PE 56/4 or pre-approved equal.
Number of pumps: 2
Power: 460v/3ph.

C. PUMP DESIGN

1. The heavy duty submersible grinder pump(s) shall be capable of handling raw unscreened sewage and other similar solids-laden fluids without clogging. The pump shall be driven by a Premium Efficiency three phase motor, providing the highest levels of operational reliability and energy efficiency.

D. GUIDE RAIL BASE ASSEMBLY

1. There shall be no need for personnel to enter the wet well to remove or reinstall the pump(s). In a wet pit installation, the discharge base & elbow assembly shall be permanently installed in the wet well and connected to the discharge piping. In order to prevent binding or separation of the pump from the guide rail system, the pump(s) shall connect to the guide rail base automatically and firmly, guided by one 2 inch guide pipe extending from the base elbow to the top of the station. Systems using guide cable in lieu of rigid guide bars or pipes shall not be considered acceptable. The sliding guide bracket shall be a separate part of the pumping unit.

   A field replaceable Nitrile (Buna-N) rubber profile gasket or o-ring shall accomplish positive sealing of the pump flange/guide rail bracket to the discharge elbow. Base assemblies which rely solely on metal to metal contact between the pump flange and discharge base elbow as a means of sealing are inherently leak prone, and shall not be considered equal. No portion of the pump shall bear directly on the floor of the sump.

E. PUMP CONSTRUCTION

1. Major pump components shall be of gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) with smooth surfaces devoid of porosity or other irregularities. All exposed fasteners shall be stainless steel, 1.4401 (AISI type 316) construction. All metal surfaces coming into contact with the pumped media (other than the stainless-steel components) shall be protected by a factory applied spray coating of zinc phosphate primer followed by a high solids two part epoxy paint finish on the exterior of the pump. The pump shall be equipped with an open lifting hoop suitable for attachment of standard chain fittings, or for hooking from the wet well surface. The hoop shall be stainless steel, 1.4401 (AISI 316), and shall be rated to lift a minimum of four times the pump weight.

   Sealing design for the pump/motor assembly shall incorporate machined surfaces fitted with Nitrile (Buna-N) rubber O-rings. Sealing will be the result of controlled compression of rubber O-rings in two planes of the sealing interface. Housing interfaces shall meet with metal to metal contact between machined surfaces, and sealing shall be accomplished without requiring a specific torque on the securing fasteners. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered equal. No secondary sealing compounds shall be required or used.

F. Grinder Mechanism:

1. The grinder mechanism shall consist of two circular, hardened cutter elements, one rotating and one stationary. The cutter material shall be similar to an AISI 440C stainless steel with the addition of cobalt, vanadium, and molybdenum for superior abrasion resistance and a hardness of Rockwell C 58-62. The rotating element shall be secured to the end of the pump shaft directly below the impeller by a stainless-steel bolt which is mechanically prevented from loosening by a positively engaged ratcheting washer assembly. It shall be keyed to the impeller so that it rotates with the motor. The head of the securing bolt shall be effectively recessed within the cutter element bore to prevent disruption of the flow stream and catching of solid material in the wastewater.

The stationary element shall be secured to the Self Cleaning Wear Plate and positioned so that it is concentric to and aligned with the rotating element. Both elements shall incorporate a sinusoidal wave pattern at the grinding interface to create a shearing and cutting action between the elements as the rotating cutter spins. The rotating cutter shall incorporate an integrated solids deflector to prevent items such as plastic bags from covering the grinder assembly and starving the pump. All wastewater being pumped by the impeller shall be drawn through the grinder mechanism by the natural suction of the pump impeller and reduced to a particle size approximately 1/8 inch. The grinder mechanism shall not require routine adjustments throughout the life of the grinder assembly.

G. Impeller

1. The impeller shall be a semi open multi vane design with a solids passage size sufficient to prevent clogging on the wastewater material that has passed through the integrated grinder assembly. The impeller material shall be gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B). The impeller shall have a slip fit onto the motor shaft and drive key, and shall be securely fastened to the shaft by a stainless-steel bolt which also holds the rotating cutter element. The impeller shall be dynamically balanced to the ISO 10816 standard to provide smooth vibration free operation.

H. Self Cleaning Wear Plate

1. The ABS ContraBlock style wear plate shall be constructed from gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B). The wear plate shall be designed to hold and secure the stationary cutter firmly in place, concentric to the rotating cutter. The impeller side of the wear plate shall incorporate an outwardly spiraling V-shaped groove to shred and force stringy solids outward from the impeller and through the pump discharge. The wear plate shall be mounted to the volute with three stainless steel securing screws and three stainless steel adjusting screws to permit close tolerance adjustment between the wear plate and impeller for maximum pump efficiency. Adjustment to allow for wear and to restore peak pumping performance shall be easily accomplished in the field utilizing standard tools, and without requiring disassembly of the pump. The use of fixed or non-adjustable wear plates or rings, or systems that require disassembly of the pump or shimming of the impeller to facilitate adjustment shall not be considered equal.

I. Pump Volute

1. The pump volute shall be single piece gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) non-concentric design with centerline discharge. Passages shall be smooth and large enough to pass any solids which may enter the impeller. Discharge size shall be 1 ¼ inch. The discharge flange design shall permit attachment to the ABS guide rail system, and shall also accept a 1 1/4"' NPT male fitting when the pump is supplied with an available NPT adapter kit. The minimum working pressure of the volute and pump assembly shall be 10 bar (145 psi).

2.3 PREMIUM EFFICIENCY MOTOR

A. Description:

1. The Premium Efficiency motor shall meet efficiency standards in accordance with IEC 60034-30, level IE3 and NEMA Premium*. Motor rating tests shall be conducted in accordance with IEC 60034-2-1 requirements and shall be certified accurate and correct by a third party certifying agency. A certificate shall be available upon request.
* IE3 and NEMA Premium efficiency levels are equivalent, however the NEMA Premium standard is intended to cover dry installed motors only, not integrated submersible motors.

The Premium Efficiency motor shall be housed in a water tight gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) enclosure capable of continuous submerged operation underwater to a depth of 20 meters (65 feet), and shall have an IP68 protection rating. The motor shall be of the squirrel-cage induction design, NEMA type B, Premium Efficiency. The copper stator windings shall be insulated with moisture resistant Class H insulation materials, rated for 180ºC (356ºF). The stator shall be press fitted into the stator housing. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is unacceptable. The rotor bars and short circuit rings shall be made of cast aluminum.

The motor shall be designed for continuous duty. The maximum continuous temperature of the pumped liquid shall be 40ºC (104ºF), and intermittently up to 50ºC (122ºF). The motor shall be capable of handling up to 15 evenly spaced starts per hour without overheating. The service factor (as defined by the NEMA MG1 standard) shall be a minimum of **1.2**. The motor shall have a voltage tolerance of +/- 10% from nominal, and a phase to phase voltage imbalance tolerance of 1%. The motor shall be FM and CSA approved for use in NEC Class I, Division I, Groups C & D hazardous locations. The surface temperature rating shall be T3C.

The motor shall be capable of operating completely submerged, at full rated power continuously without the need for de-rating or reduced duty cycle. It shall be self-cooling via the process fluid surrounding the motor. The motor shall have a NEMA Class A temperature rise

B. Thermal Protection: Each phase of the motor shall contain a normally closed bi-metallic temperature monitor switch imbedded in the motor windings. These thermal switches shall be connected in series and set to open at 140ºC +/- 5ºC (284ºF). They shall be connected to the control panel, and used in conjunction with, and supplemental to, external motor overload protection.

C. Mechanical Seals: Each pump shall be equipped with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary industrial duty silicon-carbide seal ring and one rotating industrial duty silicon-carbide seal ring. The stationary ring of the primary seal shall be installed in a seal holding plate of gray cast iron EN-GJL-250 (ASTM A-48, Class 35B). The seal holding plate shall be equipped with swirl disruption ribs to prevent abrasive material from prematurely wearing the seal plate. The upper, secondary seal unit, located between the lubricant chamber and motor housing, shall contain one stationary industrial duty silicon-carbide seal ring, and one rotating one rotating industrial duty silicon-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall not require routine maintenance, or adjustment, and shall not be dependent on the direction of rotation for proper sealing. Each pump shall be

provided with a lubricant chamber for the shaft sealing system which shall provide superior heat transfer and maximum seal cooling. The lubricant chamber shall be designed to prevent overfilling, and to provide lubricant expansion capacity. The drain and inspection plug shall have a positive anti-leak seal, and shall be easily accessible from the outside of the pump. The seal system shall not rely upon the pumped media for lubrication and shall not be damaged when the pump is run dry. Lubricant in the chamber shall be environmentally safe nontoxic material.

The following seal types shall not be considered equal: Seals of proprietary design, or seals manufactured by other than major independent seal manufacturing companies. Seals requiring set screws, pins, or other mechanical locking devices to hold the seal in place, conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces, any system requiring a pressure differential to seat the seal and ensure sealing.

D. Mechanical Seal Protection System:
The primary mechanical seal shall be protected from interference by particles in the waste water, including fibrous materials, by an active Seal Protection System integrated into the impeller and volute, and by the grinder mechanism ahead of the impeller. The back side of the impeller shall be equipped with pump out vanes to eject any fibrous material that attempts to lodge behind the impeller. The volute housing adjacent to the back side pumping vanes of the impeller shall incorporate an outward spiraling groove as described in the "Self Cleaning Wear Plate" section above, to eject solid materials from the mechanical seal area. Fibrous material which attempts to lodge behind the impeller, or wrap around the mechanical seal shall be effectively ejected by the system preventing interference with the mechanical seal. The Seal Protection System shall operate whenever the pump operates, and shall not require adjustment or maintenance in order to function. Grinder pump designs which do not incorporate an active system to protect the primary mechanical seal shall not be considered acceptable for wastewater service.

E. Seal Failure Early Warning System: The integrity of the mechanical seal system shall be continuously monitored during pump operation and standby time. An electrical probe shall be provided in a sensing chamber positioned between the primary and secondary mechanical seals for detecting the presence of water contamination within the chamber. The sensing chamber shall be filled with environmentally safe nontoxic oil. A solid-state relay mounted in the pump control panel or in a separate enclosure shall send a low voltage, low amperage signal to the probe, continuously monitoring the conductivity of the liquid in the sensing chamber. If sufficient water enters the sensing chamber through the primary mechanical seal, the probe shall sense the increase in conductivity and signal the solid state relay in the control panel. The relay shall then energize a warning light on the control panel, or optionally, cause the pump shut down. This system shall provide an early warning of mechanical seal leakage, thereby preventing damage to the submersible pump, and allowing scheduled rather than emergency maintenance. Systems utilizing float switches or any other monitoring devices located in the stator housing rather than in a sensing chamber between the mechanical seals are not considered to be early warning systems, and shall not be considered equal.

F. Shaft: The pump shaft and motor shaft shall be an integral, one piece unit adequately designed to meet the maximum torque required at any normal start-up condition or operating point in the

system. The shaft shall have a full shutoff head design safety factor of 1.7, and the maximum shaft deflection shall not exceed .05 mm (.002 inch) at the lower seal during normal pump operation. Each shaft shall be stainless steel 1.4021 (AISI 420) material, and shall have a polished finish with accurately machined shoulders to accommodate bearings, seals and impeller. Carbon steel, chrome plated, or multi piece welded shafts shall not be considered adequate or equal.

G. Bearings: Each pump shaft shall rotate on high quality permanently lubricated, greased bearings. The upper bearing shall be a deep grooved ball bearing and the lower bearings shall be a heavy duty double row angular contact ball bearing. Bearings shall be of sufficient size and properly spaced to transfer all radial and axial loads to the pump housing and minimize shaft deflection. L-10 bearing life shall be a minimum of 50,000 hours at flows ranging from ½ of BEP flow to 1.2 times BEP flow (BEP is best efficiency point). The bearings shall be manufactured by a major internationally known manufacturer of high quality bearings, and shall be stamped with the manufacturer's name and size designation on the race. Generic or unbranded bearings from other than major bearing manufacturers shall not be considered acceptable.

H. Power Cable: The power cables shall be sized according to NEC and CSA standards and shall be of sufficient length to reach the junction box without requiring splices. The outer jacket of the cable shall be oil and water resistant, and shall be capable of continuous submerged operation underwater to a depth of 65 feet.

I. Cable Entry System: The cable entry system shall consist of submersible plug assembly which allows the cable be easily disconnected from the pump for service or replacement. Cable sealing shall be accomplished by a Nitrile compression grommet with both cylindrical and conical sealing surfaces, flanked by a stainless-steel washer and an integrated strain relief. A brass (C3604) compression nut shall be threaded into to the cast iron EN-GJL-250 (ASTM A-48, Class 35B) cable plug housing, compressing the grommet ID to the cable while the grommet OD seals against the bore of the cable entry housing. Cable conductors shall be terminated in copper pin connectors which are separated and retained by a circular pin retainer fabricated from high dielectric strength Polyamid (30% GF). Each pin shall pass through its own hole in the pin retainer, maintaining perfect alignment with the mating pins in the motor body. The corresponding motor body pin assembly shall be manufactured from high dielectric strength Polyamid (30% GF), with copper connector pins. The pin assembly shall be sealed with an o-ring to prevent water entry into the motor, and retained in the motor housing bore via a retaining ring. Attachment of the plug assembly to the motor shall engage the corresponding copper pins, creating a complete circuit between the motor and cable. The plug assembly shall be fastened with stainless steel fasteners, and shall be sealed by an o-ring.

The cable plug and sealed entry system as part of the motor shall be FM and CSA approved for use in NEC Class I, Division I, Groups C & D hazardous locations. The system shall be anti wicking by design, and shall prevent any water that enters the cable through damage to the jacket from entering the motor. Cable entry designs which utilize potting compounds to provide a water tight seal, or those which do not allow the cable to be easily changed in the field shall not be considered equal.

2.4 HALLIDAY HOIST

A. (1) 304 Stainless steel hoist model D2B 36D, 30’ of ¼” stainless steel cable, galvanized 1 ton hook. Dutton-Lainson marine grade brake winch, adjustable reach in 1” increments.

B. (1) 304 Stainless steel embedded hoist socket model D1R.

2.5 COMMINUTOR

A. Model: JWC Model 30005-0008-DI Muffin Monster or approved equivalent.

B. Manufacturer: JWC Environmental Inc.

C. Components: JWC Two Shafted Grinder with 8” cutter stack using "using 17-tooth "Wipes Ready" cutters that shall be alloy steel heat treated to 45-53 HRc with radial serrations on the leading edges designed to perforate material as it passes between the cutter and adjacent spacer, the spacers will be alloy steel heat treated to 34-53 HRc with a knurled outside edge designed to assist in the tearing of material passing through the cutter stack, cartridge-style tungsten carbide mechanical seals with BUNA-N elastomers rated for 90 psi, green epoxy-coated ductile iron end housings and delta p siderails, optimized cut gearing, 29:1 speed reducer and 3 HP XPNV 208 -230/460v/3ph/60Hz Immersible Electric Motor, 60' cable. Redundant comminutor to be provided as spare.

D. Mounting: Wet Well-Mounted Frame for a round manhole, and 10’ Slide Rail fabricated of Stainless Steel with Lifitng Ball

E. Controller: PC2200 Motor Controller in a NEMA 4X FRP enclosure accepting 230v/3ph/60Hz or 460v/3ph/60Hz input power, includes IEC starter with over-current protection, jam-sensing current transformer and micro-PLC

2.6 GridBee AP500 Air Powered Mixer System by IXOM Watercare

PART 1 - GENERAL

A. Equipment Overview
   1. These specifications provide the requirements to furnish, install and place into operation circulation equipment at the Fayette County Prison site.

B. References
   1. Occupational Safety and Health Administration, OSHA

C. Quality Assurance
   1. Continuous Operation Equipment. The circulation equipment shall be designed for continuous operation, all day and all night, using an air supply unit powered from the electric grid.

   2. No Visual Defects. The circulation equipment shall have no visual defects, and shall have high quality welds and assembly, and corrosion resistant finish.

3. Qualified US Manufacturer. The manufacturer of the equipment shall have extensive experience in the production of such equipment, and the equipment shall be manufactured in the continental United States.

3. Warranty. GridBee AP air-powered mixers and circulators are warranted to be free of defective parts, materials, and workmanship for a period of 2 years from the date of installation. GridBee air pumps, air compressors, control panels, and any optional accessories are "buyout" items for Ixom Watercare, Inc., and include a warranty against defects in material and workmanship for 1 year from the date of purchase. This warranty covers parts only, not labor. Parts that are determined by Ixom Watercare, Inc. to be defective in material or workmanship under normal use during the 1 year warranty period will be repaired or replaced. Shipping charges are the responsibility of the customer.

D. Submittals

1. The awarded Bidder shall provide [2] copies of the following documents. Upon acceptance of these documents by the Engineer, the Bidder will be issued a Notice to Proceed, and may then proceed to install the equipment.
   a. A statement of the quantity and model number of the machines that would be provided for the wet well to comply with the required flow rates shown in Section 2.02 below.
   b. A copy of the circulation equipment warranty in compliance with Section 1.03.
   c. Shop drawings and specifications for the circulation equipment to be provided, in compliance with Section 2.02.
   d. Manufacturer's literature, illustrations and specification sheets.

PART 2 – PRODUCT SPECIFICATIONS

A. Manufacturer

1. Specified Equipment. The circulation equipment shall be manufactured by Ixom Watercare, Inc. of Dickinson, ND, or be a pre-approved alternative.

2. Pre-approved Alternative(s). Alternatives to the specified equipment will be considered on the following basis only.

   a. Ten (10) Days Before Bid. To offer equipment as a pre-approved alternative, written application from the alternative supplier shall be made to the Engineer at least 10 days in advance of the bid opening.

   b. No Material Difference in Quality of Equipment or in Vendor Support. The application should include:

      1. A brief description of how the offered alternative does or does not meet each of the specifications in this document.
      2. An analysis of how acceptance of the alternative equipment would likely affect the overall water quality goals of the project.

3. A statement of the science and support background of the supplier of the alternative equipment, so that the benefits and costs of the alternative equipment to the Owner can be estimated by the Engineer.

c. Five (5) Days Notice to Bidders. If the alternative equipment is accepted by the Engineer, an informational addendum to these specifications shall be distributed by the Engineer to plan holders at least 5 days in advance of the bid opening.

B. Performance and Features

1. Construction. The mixing equipment metal housing, intake plate and air manifold shall be constructed primarily of Type 316 stainless steel, it shall also undergo a passivation bath, also known as stainless steel pickling, to restore corrosion resistance to the welds and other areas of imperfections. The air distribution system shall be constructed primarily of glass filled polypropylene and EPDM.

2. Air Supply Unit. The circulation equipment shall be driven by an air supply unit with the following features:

   1/2 HP rated air pump capable of producing 6.0 cubic feet per minute (0.17 cubic meters per minute) @ 4 psi (27.6 kiloPascal) consuming 1/2 HP (375 Watt) power. Includes weatherproof housing and contains 120vAC cord and plug. Requires 120vAC, 20 Amp, receptacle for power source.

3. Maintenance Requirements. The circulation equipment shall operate normally with the following maintenance features.

   a. No scheduled lubrication is required of any system components.
   b. No spare parts shall be required to be kept on hand.
   c. No tools beyond normal cleaning supplies and a few common hand tools shall be required for scheduled maintenance.

4. Solids Handling: The circulation equipment shall be capable of passing up to 4 inch spherical solids.

5. Flotation: The circulation equipment shall have an optional flotation system designed to support mixer when required.

PART 3 – EXECUTION

A. Contractor Installation

1. Installation, Placement and Startup shall be provided by others and not the factory equipment manufacturer to include:

   a. Refer to GridBee Air Powered Mixer Owners Manual for the latest installation guidelines.

   b. Air Supply Unit Installation – Place the air pump in open space with adequate ventilation and shaded to prevent overheating.

2.7 MATERIALS

A. Bedding, Ballast, and Backfill.

1. Bedding: as specified in Section 31 0516 - Aggregates for Earthwork.
2. Aggregate Ballast and Backfill: as specified in Section 31 0516 - Aggregates for Earthwork

2.8 APPURTENANCES

A. Pump Guide Rails:

1. Material: Type 304 stainless steel.
2. Diameter: Manufacturer's standard for pump size, but not less than 1 inch .

B. Top and Bottom Pilots: Stainless steel.

C. Pump Guides and Guide Rail Supports: Stainless steel.

D. Pump-Lifting Cable: Stainless steel.

E. Fasteners and Hardware: Type 316 stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify layout and orientation of pumps, accessories, and piping connections.

3.2 INSTALLATION

A. Coordinate location of pump control panel with Architect

B. Excavation: As specified in Section 31 2316 - Excavation.

C. Install pump units and accessories where indicated on Drawings and according to manufacturer's instructions.

D. Backfill: As specified in Section 31 2323 - Fill.

E. Provide and connect piping, accessories, and power and control conduit and wiring to make system operational and ready for startup.

F. Flush piping with clean water.

3.3 FIELD QUALITY CONTROL

A. See Division 01 requirements for inspecting and testing.

B. Inspection: Check and adjust liquid-level control and alarm settings.

C. Start-up and Performance Testing:

1. Test each unit on clear water through minimum of four complete cycles under supervision of manufacturer's representative and in presence of Architect/Engineer.
2. Demonstrate that system performance, control functions, and alarms meet specified requirements.
3. Hydrostatically test system piping for leaks at 40 psig.

D. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

E. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Demonstrate equipment startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Owner's personnel.

3.5 PROTECTION

A. Conduct operations as to not interfere with, interrupt, damage, destroy, or endanger integrity of surface structures or utilities in immediate or adjacent areas to the Work.

END OF SECTION

SECTION 33 4100
STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to requirements of this Section.

1.2 SUMMARY

A. Section Includes:
1. Storm drainage piping.
2. Accessories.
3. Cleanouts.
4. Bedding and cover materials.
5. Foundation Drainage

B. Related Sections:
1. Section 31 0513 - Soils for Earthwork: Soils for backfill in trenches.
2. Section 31 0516 - Aggregates for Earthwork: Aggregate for backfill in trenches.
3. Section 31 2316 - Excavation: Product and execution requirements for excavation and backfill required by this section.
4. Section 31 2316.13 - Trenching: Execution requirements for trenching required by this section.

1.3 UNIT PRICE - BASIS OF MEASUREMENT – NOT USED

1.4 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
2. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
3. ASTM C969 - Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
4. ASTM C1103 - Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
5. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

6. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
7. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
8. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
9. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
10. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
11. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
12. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
13. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
14. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

C. PennDOT Publication 408, current edition.

D. PennDOT Publication 72M, RC Standards, current edition.

E. PennDOT Bulletin 15.

F. PADEP Erosion and Sediment Pollution Control Program Manual, dated March 2012 and all corrections.

1.5 SUBMITTALS

A. Product Data: Submit data indicating pipe, pipe accessories, reinforcement, and manufacturer

B. Manufacturer's Installation Instructions: Submit special procedures required to install Products specified.

C. Manufacturer's Certificate: Certify Products meet or exceed PennDOT publication 408 requirements.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents:
1. Accurately record actual locations of pipe runs, connections, catch basins, cleanouts, and invert elevations on record drawings.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with municipal and PennDOT Publication 408 standards.

B. Comply with applicable portions of Conservation District regulations pertaining to storm sewage systems.

C. Verify all existing storm utility inverts and finished grades prior to starting work.

1.8 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.9 COORDINATION

A. Coordinate the Work with termination of storm sewer connection outside building, trenching, connection to municipal sewer utility service.

PART 2 - PRODUCTS

2.1 STORM DRAINAGE PIPING

A. Plastic Piping (PVC):
   1) Pipe:
      a) Material: PVC.
      b) Comply with ASTM D3034 and D2680, SDR 35 unless stated otherwise on project drawings.
      c) Inside Nominal Diameter: as specified on project drawings.
      d) Style: Bell and spigot with rubber-ring sealed gasket joint.
   2) Fittings: PVC.
   3) Joints:
      a) Comply with ASTM F477.
      b) Gaskets: Elastomeric.

B. Plastic Piping (HDPE):
   1) Pipe:
      a) Material: High Density Polyethylene Culvert Pipe, smooth interior. ADS or equivalent.
      b) Comply with AASHTO M294
      c) Inside Nominal Diameter: as specified on project drawings.
      d) Style: Polyethylene sleeve with gasket.

2.2 ACCESSORIES

A. Filter Fabric: Non-biodegradable, non-woven, per drawings

2.3 CATCH BASINS, YARD DRAINS, AND CLEANOUTS

A. Furnish materials in accordance with PennDOT Publication 408 standards for suppliers approved in Bulletin 15 Approved Construction Materials

B. The Contractor shall provide precast inlets at the locations and to the dimensions and elevations shown on the drawings. The inlets shall be the type inlets indicated on the drawings and constructed as specified by the municipal standard construction details, PennDOT Standard Construction Details, and PennDOT RC-standards, latest edition, and as shown on the plans. Included shall be all necessary excavation, precast concrete sections, steps, gaskets, brick

masonry, frame and grate, concrete low flow channels, backfilling and all necessary appurtenances for completion. Include all weepholes indicated on inlets to provide sub-surface drainage from adjoining areas. Where precast structures cannot be installed due to elevation limitations or utility conflicts, poured in place structures can be substituted.

C. Provide polypropylene plastic steps conforming to ASTM D4141-95B with a ½" deformed reinforcing rod, Grade 60, conforming to ASTM A615.

2.4 BEDDING AND COVER MATERIALS

A. Clean #57 stone as detailed on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify trench cut; excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

B. Perform complete site review and investigation, research public utility records, and verify existing utility locations. Contact utility-locating service for area where project is located.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with coarse aggregate lean concrete.

B. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 31 2316.13 - Trenching for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.

B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 6 inches compacted depth, as shown on drawings.

C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Refer to Section 31 2323 - Fill for backfilling and compacting requirements. Do not displace or damage pipe when compacting.

B. Refer to Section 33 0516.13 – Precast Concrete Utility Structures for manhole requirements.

C. Install Work in accordance with municipal and PennDOT Publication 408 standards.

D. Install all pipe beginning at the downstream end working upstream. Confirm elevations at both ends prior to starting work.

3.5 INSTALLATION - CATCH BASINS AND CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.

B. Form and place Cast-In-Place Concrete base pad, with provision for storm sewer pipe end sections.

C. Level top surface of base pad; sleeve concrete shaft sections to receive storm sewer pipe sections.

D. Establish elevations and pipe inverts for inlets and outlets as indicated on Drawings.

E. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

F. Install Work in accordance with municipal and PennDOT Publication 408 standards

3.6 FIELD QUALITY CONTROL

A. Request inspection prior to and immediately after placing aggregate cover over pipe.

B. Contact Professional 48 hours prior to installation of Subsurface detention basins.

C. When tests indicate work does not meet specified requirements, remove work, replace and retest.

3.7 PROTECTION OF FINISHED WORK

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.
   1. Take care not to damage or displace installed pipe and joints during construction of pipe supports, backfilling, testing, and other operations.
   2. Repair or replace pipe that is damaged or displaced from construction operations.

END OF SECTION