PROJECT MANUAL

FOR THE

WESTERN REGIONAL WATER SUPPLY FACILITY IMPROVEMENTS – PHASE 3A – PART 2

Volume 2 of 2

Prepared For:

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ORANGE COUNTY
WESTERN REGIONAL WATER SUPPLY FACILITY IMPROVEMENTS
PHASE 3A – PART 2

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DIVISION 10

SPECIALTIES

SECTION 10140

SIGNAGE SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Extent of specialty signs as shown on Drawings, and as specified herein. The Contractor shall furnish all labor, materials, equipment, and incidentals required to install signage.

1. The Contractor shall furnish all labor, materials, equipment, and incidentals required to install signage as specified herein and as described in the drawings.

B. Forms of specialty signs required include the following:

1. Panel signs.
2. Metal letters and numbers.

C. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 REFERENCES

A. Federal Specifications

1. QQ-A-200/8D: 6063 Aluminum alloy bar, rod, shapes, tube, and wire.
2. QQ-A-250/2D: 3003 Aluminum alloy plate and sheet.

B. Local Specifications

1. 2014 Florida Building Code

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01340, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Drawings for fabrication and erection of specialty signs. Include the following:

a. Plans, elevations, and large-scale details of sign wording and lettering layout.

b. Anchorages and accessory items indicated.

c. Location template Drawings for items supported or anchored to permanent construction.

d. Sign Schedule.

1.04 QUALITY ASSURANCE

A. Uniformity of Manufacturer: For each sign form and graphic image process indicated, furnish products of a single manufacturer.

B. Coordinate all interior and exterior graphic sign descriptions with Owner and provide schedule prior to fabrication.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Panel Signs, Handicapped Symbol Signs, and Exterior Freestanding Signs:

a. ABC Signing Division of Nelson-Harkins Industries.
b. Andco Industries Corp.
c. APCO Graphics, Inc.
d. Architectural Graphics, Inc.
e. ASI Sign Systems, Inc.
f. Charleston Industries, Inc.
g. DGS Corp.
h. Diskey Sign Corporation.
i. Mohawk Sign Systems.
j. Spanjer Brothers, Inc.
k. The Supersine Company.

2. Metal Letters:

a. A.C. Davenport and Son.
b. Andco Industries, Inc.
c. A.R.K. Ramos Manufacturing Company, Inc.
d. ASI Sign Systems, Inc.
e. Matthews.
f. Metal Arts, Division of L&H Manufacturing Co.
g. Metallic Arts.
h. Spanjer Brothers, Inc.
i. The Southwell Company.
j. The Supersign Company.

B. ROOM IDENTIFICATION SIGNS

1. Signs shall consist of a removable plaque inserted in square cornered extruded aluminum frames with a grey 1/16-inch perimeter reveal separating plaque insert and frames.

2. Plaques shall be 3/16-inch thick engraved stock with a sub-layer of contrasting color. Lettering on the plaque shall be 1-inch high, Helvetica Medium font, in all caps.

3. Extruded frame shall have a minimum thickness of 1/16-inch and overall frame thickness of 3/8-inch. Frame finish shall be a dark duranodic.

4. Mounting:

   a. Room Signs with numbers mounted on all exterior doors.

   b. Door mounted signs shall me mechanically fastened with stainless steel counter sunk screws. Signs shall be mounted in the center of the door, 5 feet – 0 inches above finished floor on the exterior side of the door.

   c. Wall mounted signs shall be affixed to a shim plate with vinyl foam tape or silastic adhesive. Shim plate shall be 0.125-inch thick aluminum with pre-drilled counter sunk holes. Plate shall be mounted to the wall with stainless steel screws. Plate shall be 5 foot-6 inches above finished floor, unless otherwise noted.

5. Signage shall be manufactured by Andco Industries Corporation, Vomar Products, Cooper Architectural Signs, or approved equal.

C. SAFETY AND RESTRICTIVE SIGNS

1. Fixed plaque signs shall consist of 1/16-inch thick, clear matte acrylic that is sub-surface printed with the sign message prior to being laminated to a 1/8-inch thick base plate of red opaque acrylic. Plaque shall have 1 inch radius rounded corners and shall be suitable for outdoor use.

2. Plaque lettering shall be 2 inch high, Helvetica Medium font, in all caps. Letters and symbols shall be of die-cut pressure sensitive vinyl.

3. Plaques shall be wall mounted and shall be affixed to a shim plate with vinyl foam tape or silastic adhesive. Shim plate shall be 0.125-inch thick aluminum with pre-drilled counter sunk holes. Plate shall be mounted to the wall with stainless steel screws.

4. Plaques shall be manufactured by Andco Industries Corporation, Vomar Products, Cooper Architectural Signs, or approved equal.

2.02 MATERIALS

A. Fiberglass (Exterior Door Plant Signs): Provide molded seamless thermosetting glass-fiber-reinforced polyester panels in sizes and thicknesses indicated, with a minimum tensile strength of 15,000 psi when tested in accordance with ASTM D 638, and a minimum flexural strength of 30,000 psi when tested in accordance with ASTM D 790.

B. Cast Acrylic Sheet (Interior Panel Signs): Provide cast (not extruded or continuous cast) methacrylate plastic sheet, in sizes and thicknesses indicated; with a minimum flexural strength of 16,000 psi when tested in accordance with ASTM D 790, a minimum allowable continuous service temperature of 176 degrees F (80 degrees C).

C. Fasteners: Unless otherwise indicated, used concealed fasteners fabricated from metals that are noncorrosive to either the sign material or the mounting surface.

D. Anchors and Inserts: Use nonferrous metal or hot-dipped galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.03 FABRICATION

A. Graphic Image Process:

1. Graphic Content and Style: Provide sign copy to comply with the requirements indicated for sizes, styles, content, positions, finishes and colors of letters, numbers, symbols, and other graphic devices.. Handicap access bathrooms shall have 1-1/4-inch-high lettering.

2. Interior Panel Signs: Fabricate panel signs to comply with the requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.

    a. Raised Sign Panels: Signs shall be 1/8-inch-thick acrylic plastic with 1/32-inch raised letters and Grade 2 Braille complying with Americans with Disabilities Act (ADA) of 1990. Letters shall be of a contrasting color with their background. Braille shall be of an integral color and material with their background. Braille tags shall not be used.

3. Metal Letters and Numbers: Provide metals letters and numbers to comply with requirements indicated for the manufacturing process, materials, finish, style, size, and message content.

a. Aluminum Sheet: Not less than 0.090-inch thick. Fabricate by the heliarc welding process.

2.04 FINISHES

A. Colors and Surface Textures: For exposed sign material that requires selection of materials with integral or applied colors, surface textures, or other characteristics related to appearance, provide color matches indicated, or if not indicated, as selected by ENGINEER from manufacturer's standards.

B. Metal Finishes: Comply with National Association of Architectural Metal Manufacturers (NAAMM) "Metal Finishes Manual" for finish designations and application recommendations.

C. Aluminum Finishes:

1. Class II Clear Anodized Fine Satin Finish: Provide AA-M31C21A31 (fine satin mechanical finish with chemical etch, fine matte finish, 0.4 mil thick minimum anodic coating).

PART 3 - EXECUTION

3.01 INSTALLATION

A. Locate sign units and accessories where shown or Scheduled, using mounting methods of type described and in compliance with the manufacturer's instructions, unless otherwise indicated. If location is not shown, it shall be as directed by ENGINEER.

1. Install sign units level, plumb, and at the height indicated with sign surfaces free from distortion or other defects of appearance.

B. Wall-Mounted Panel Signs: Attach panel signs to wall surfaces using the methods indicated below:

Vinyl Tape Mounting: Use double-sided foam tape, of the thickness indicated, to mount signs to smooth non-porous surfaces. Do not use this method for vinyl-covered or rough surfaces.

C. Metal Letters and Numbers: Mount letters and numbers using standard fastening methods recommended by manufacturer for the letter form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish letter spacing and to locate holes for fasteners.

1. Projected Mounting: Mount letters at the projection distance from wall surface indicated.

3.02 CLEANING AND PROTECTION

A. At completion of installation, clean soiled sign surfaces in accordance with manufacturer's instructions. Protect units from damage until acceptance by OWNER.

END OF SECTION

SECTION 10200

ALUMINUM LOUVERS AND VENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fixed metal wall louvers.
2. Blank-off panels for wall louvers.
3. Wall and attic vents.

B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 DEFINITIONS

A. Louver Terminology: Refer to AMCA Publication 501-85 for definitions of terms for metal louvers not otherwise defined in this Section, or referenced standards.

1.03 PERFORMANCE REQUIREMENTS

A. Structural Performance: Design, engineer, fabricate, and install exterior metal wall louvers to withstand the effects of loads and stresses from wind and normal thermal movement without evidencing permanent deformation of louver components including blades, frames, and supports; noise or metal fatigue caused by louver blade rattle or flutter, and permanent damage to fasteners and anchors:

1. Refer to Components and Cladding Table on structural drawings Sheet S-0002 for wind pressures.

2. Normal thermal movement is defined as that resulting from the following maximum change (range) in ambient temperature. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.

a. Temperature Change (Range): 100 degrees F (55.5 degrees C).

B. Air Performance, Water Penetration, and Air Leakage Ratings: Provide louvers complying with performance requirements indicated as demonstrated by testing manufacturers' stock units, of height and width indicated, according to Air Movement and Control Association (AMCA) Standard 500.

1.04 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Drawings of louver units and accessories. Include plans, elevations, sections, and details showing profiles, angles, spacing of louver blades, unit dimensions related to wall openings and construction, free areas for each size indicated, fastener details, and profiles of frames at jambs, heads, and sills.

2. Product data for each product indicated including headloss through louver and screen.

3. Provide Florida Product Approval (FPA) number per Florida Building Code using one of the methods outlined in Chapter 9N-3 of the Department of Community Affairs, Florida Building Commission.

4. Samples for initial selection purposes in form of manufacturer's color charts showing full range of colors available for those units with factory-applied color finishes.

5. Samples for verification purposes of each type of metal finish required, prepared on 6-inch square metal samples of same thickness and alloy indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing full range of variations expected.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain louvers and vents from a single source where alike in one or more respects with regard to type, design, and factory-applied color finish.

B. Codes and Standards:

1. Qualify welding processes and welding operators in accordance with D1.2, "Structural Welding Code - Aluminum," and D1.3, "Structural Welding Code - Sheet Steel."

a. Certify that each welder employed in unit of Work of this Section has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

b. Testing for recertification is CONTRACTOR's responsibility.

c. Comply with SMACNA "Architectural Sheet Metal Manual" recommendations for fabrication, construction details, and installation procedures.

1.06 PROJECT CONDITIONS

A. Field Measurements: Check actual louver openings by accurate field measurements before fabrication; show recorded measurements on final Shop Drawings. Coordinate Fabrication schedule with construction progress to avoid delay of Work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Louvers:

a. Airolite Co.
b. American Warming and Ventilating, Inc.
c. Construction Specialties, Inc.
d. Industrial Louvers, Inc.
e. Greenheck Fan Corporation.
f. Ruskin Manufacturing Division, Phillips Industries, Inc.

2. Metal Wall Vents (Brick Vents):

a. Airolite Co.
b. Construction Specialties, Inc.
c. Industrial Louvers, Inc.
d. Riesner Vent Brick Corp.
e. Ruskin Manufacturing Division, Phillips Industries, Inc.
f. Sunvent Industries, Sylro Sales Corp.

2.02 MATERIALS

A. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005, with temper as required for forming or as otherwise recommended by metal producer to produce required finish.

B. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.

C. Fasteners: Of same basic metal and alloy as fastened metal, unless otherwise indicated. Do not use metals which are corrosive or incompatible with materials joined.

1. Use types, gauges, and lengths to suit unit installation conditions.

2. Use Phillips flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Anchors and Inserts: Of type, size, and material required for type of loading and installation indicated. Use nonferrous metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or expansion bolt devices for drilled-in-place anchors.

E. Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic).

2.03 FABRICATION, GENERAL

A. Fabricate louvers and vents to comply with requirements indicated for design, dimensions, materials, joinery, and performance.

B. Preassemble louvers in shop to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of size indicated with allowances made for fabrication and installation tolerances of louvers, adjoining construction, and perimeter sealant joints.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Provide vertical mullions of type and at spacings indicated, but not further apart than recommended by manufacturer, or 72 inches on center, whichever is less. At horizontal joints between louver units, provide horizontal mullions except where continuous vertical assemblies are indicated.

G. Provide sill extensions and loose sills made of same material as louvers, where indicated, or required for drainage to exterior and to prevent water penetrating to interior.

H. Join frame members to one another and to fixed louver blades as follows, unless otherwise indicated, or size of louver assembly makes bolted connections between frame members necessary:

1. With fillet welds concealed from view, and concealed from view mechanical fasteners only where required for continuous assemblies.

2.04 FIXED EXTRUDED ALUMINUM WALL LOUVERS

1. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

A. Horizontal, Drainable Fixed Blade Louvers: Extruded aluminum frames and louver blades, designed to collect and drain water to exterior at sill by means of gutters in front edges of blades and of channels in jambs and mullions, complying with the following requirements.

1. Louver Depth: 4 inches, unless otherwise indicated.

2. Frame Thickness: 0.081 inch unless otherwise indicated.

3. Louver Blade Thickness: 0.081 inch unless otherwise indicated.

4. Louver Blade Angle: 45 degrees unless otherwise indicated.

5. Performance Requirements: As follows, determined by testing units 48 inches wide by 48 inches high per AMCA Standard 500:

a. Louver-free Area: Not less than 7.34 square feet.

6. Static Pressure Loss: Not more than 0.15 inch water gauge at an airflow of 1,000 fpm free area intake velocity.

a. Water Penetration: Not more than 0.02 ounce per square foot of free area at an airflow of 1,450 fpm free area velocity when tested for 15 minutes.

7. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.05 LOUVER SCREENS

A. Provide each exterior louver with louver screens complying with the following requirements:

1. Screen Location for Fixed Louvers: Exterior face unless otherwise indicated.
2. Screening Type: Bird screening on all exhaust louvers unless otherwise indicated.
3. Screening Type: Insect screening on all intake louvers unless otherwise indicated.

B. Secure screens to louver frames with stainless steel machine screws, spaced at each corner and at 12-inch on center between.

C. Louver Screen Frames: Fabricate screen frames with mitered corners to louver sizes indicated and to comply with the following requirements:

1. Metal: Same kind and form of metal as indicated for louver frames to which screens are attached.

    a. Reinforce extruded aluminum screen frames at corners with clips.

2. Finish: Same finish as louver frames to which louver screens are attached.

3. Type: Rewireable frames with a driven spline or insert for securing screen mesh.

D. Louver Screening for Aluminum Louvers: Fit aluminum louver screen frames with screening covering louver openings and complying with the following requirements:

1. Bird Screening: 1/4-inch square mesh formed with 0.080-inch-diameter aluminum wire.

2. Insect Screening: 18 by 16-mesh formed with 0.012-inch-diameter aluminum wire.

2.06 WALL AND ATTIC VENTS

A. Extruded Aluminum Wall Vents: Extruded aluminum louvers and frames not less than 0.125-inch thick and assembled by welding, with 18 by 14-mesh aluminum wire insect screening on inside face. Incorporating weep holes, continuous drip at sill, and integral water stop on inside edge of sill, of load-bearing design and construction.

2.07 FINISHES

A. Comply with National Association of Architectural Metal Manufacturers (NAAMM) "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

B. Finish louvers after assembly.

C. High-Performance Organic Coating: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: chemical conversion coating, acid chromate-fluoride-phosphate pretreatment; Organic Coating color as selected by Owner). Prepare, pre-treat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's instructions.

1. Fluorocarbon Two-Coat Coating System: Manufacturer's standard 2-coat thermo-cured system, composed of specially formulated inhibitive primer and fluorocarbon color topcoat containing not less than 70 percent polyvinyldene resin by weight, complying with AAMA 605.2.

2. Color and Gloss: As selected by OWNER from manufacturer's standard choices for color and gloss.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Site.

3.02 INSTALLATION

A. Locate and place louver units plumb, level, and in proper alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding operations required for fitting and jointing. Restore finishes so there is no evidence of corrective Work. Return items which cannot be refinished in field to shop, make required alterations, and refinish entire unit, or provide new units.

F. Protect nonferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry, or dissimilar metals.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where required to make louver joints weathertight. Comply with Section 07900 for sealants applied during installation of louver.

3.03 ADJUSTING AND PROTECTION

A. Protect louvers and vents from damage of any kind during construction period, including use of temporary protective coverings where needed and approved by louver manufacturer. Remove protective covering at time of Substantial Completion.

B. Restore louvers and vents damaged during installation and construction period so that no evidence remains of correction Work. If results of restoration are unsuccessful, as judged by ENGINEER, remove damaged units and replace with new units.

C. Clean and touch-up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

3.04 CLEANING

A. Periodically clean exposed surfaces of louvers and vents which are not protected by temporary covering to remove fingerprints and soil during construction period; do not let soil accumulate until final cleaning.

B. Before final inspection, clean exposed surfaces with water and with a mild soap or detergent not harmful to finishes. Rinse thoroughly and dry surface.

END OF SECTION

SECTION 10522

FIRE EXTINGUISHERS AND ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Extent of fire extinguishers and accessories as indicated on Drawings and Schedule.

B. Types of products required include:

1. Fire extinguishers.
2. Mounting brackets.

C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 DEFINITIONS

A. Fire Extinguishers: Refers to units which can be hand carried, as opposed to those which are equipped with wheels or to fixed fire extinguishing systems.

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01340, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Submit product data for each type of product included under this Section.

2. Submit samples of each required finish for verification purposes. Prepare samples on metal of same gauge as used for actual production run. Where normal color variations are to be expected, include two or more units in each sample set showing limits of such variations.

a. For initial selection of colors and finishes, submit manufacturer's color cards showing full range of standard colors available.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain products under this Section from one manufacturer.
B. Codes and Standards:

1. UL Listed Products: Provide new, portable fire extinguishers which are UL listed and bear UL "Listing Mark" for type, rating, and classification of extinguisher indicated.

2. FM Listed Products: Provide new, portable fire extinguishers which are approved by Factory Mutual Research Corporation for type, rating, and classification of extinguisher indicated and carry appropriate FM marking.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Fire Extinguishers and Accessories:

a. Amerex Corporation.
b. Badger Fire Protection.
c. J.L. Industries.
d. Kidd Frynetics.
e. Larsen's Manufacturing Co.
f. Potter Roemer, Div. of Smith Industries, Inc.
g. Accessory Specialties.
h. Bobrick Washroom Equipment.

2.02 FIRE EXTINGUISHERS

A. Portable fire extinguishers shall be purchased, certified, and installed by a local supplier who has a maintenance contract on OWNER's existing installation, or can provide such a contract if none exists. Provide fire extinguishers for each extinguisher cabinet and other locations indicated, in colors and finishes selected by ENGINEER from manufacturer's standard, which comply with requirements of governing authorities. The fire extinguishers shall have a minimum 1-year warranty and shall include inspection and recharging at end of 1 year.

1. All units shall comply with Underwriter's standards. Valves shall be aluminum or brass.

2. Extinguishers shall be red in color to conform to OSHA standards, sized as noted on Fire Extinguisher Schedule appended, and shall be made of all metal for tank, valve, and valve stem.

3. Extinguisher shall be mounted with wall-mount bracket unless cabinets are called for on Fire Extinguisher Schedule.

4. Fill and service extinguishers to comply with requirements of governing authorities and manufacturer's requirement.

5. Abbreviations indicated below to identify extinguisher types relate to UL classification and rating system and not necessarily to type and amount of extinguishing material contained in extinguisher.

B. Stored Pressure Water Mist Type: UL-rated 2-A:C, 2-1/2-gallon nominal capacity, in enameled steel container with pressure indicating gauge, for Class A and Class C fires.

C. Carbon Dioxide Type: UL-rated 10-B:C, 15-pound nominal capacity, in manufacturer's standard enameled metal container, for Class B and Class C fires.

D. Dry Chemical Type: UL-rated 40-B:C, 10-pound nominal capacity, in enameled steel container, for Class B and Class C fires.

E. Multi-Purpose Dry Chemical Type: UL-rated 2-A:10:B:C, 5-pound nominal capacity, in enameled steel container, for Class A, Class B, and Class C fires.

F. Multi-Purpose Dry Chemical Type: UL-rated 4-A:60-B:C, 10-pound nominal capacity, in enameled steel container, for Class A, Class B, and Class C fires.

G. Clean-Agent Type in Brass Container: UL-rated 2-A:10:B:C, 15-pound nominal capacity, in chrome plated brass container, for Class A, Class B, and Class C fires.

2.03 MOUNTING BRACKETS

A. Provide manufacturer's standard bracket designed to prevent accidental dislodgement of extinguisher, of sizes required for type and capacity of extinguisher indicated in manufacturer's standard plated finish.

1. Provide brackets for extinguishers not located in cabinets.

2. Provide brackets for extinguishers not located in cabinets and for those located in cabinets, where indicated or required.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install items included under this Section in locations and at mounting heights indicated, or if not indicated, at heights to comply with applicable regulations of governing authorities.

1. Securely fasten mounting brackets to structure, square and plumb, to comply with manufacturer's instructions.

2. Where exact location of surface-mounted bracket-mounted fire extinguishers is not indicated, locate as directed by ENGINEER.

3. Mount bracket-mounted fire extinguishers weighing 40 pounds or less at 4’-6” above finish floor to the top of the fire extinguisher; for those weighing more than 40 pounds, at 3’-6” above finish floor to the top of the fire extinguisher.

3.02 IDENTIFICATION

A. Identify bracket-mounted extinguishers with red letter decals spelling "FIRE EXTINGUISHERS" applied to wall surface. Letter size, style, and location as selected by ENGINEER.

FIRE EXTINGUISHER SCHEDULE

Room No.	Location	Bracket	Cabinet	Type and Quality				Remarks
				Clean Agent 2A-10BC	Dry Chemical 2A-10BC	CO_2 10BC-15	Water-Mist 2A-C	
See Plan	Refer to Life Safety Plans on Sheet A-0002 for quantity and location of fire extinguishers.	X			X			

END OF SECTION

SECTION 10800

TOILET ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Extent of each type of toilet accessory as indicated on Schedules on Drawings.

B. Types of toilet accessories required include (see Toilet Accessories Schedule on Drawings):

1. Private-use bathroom accessories.
2. Underlavatory guards.
3. Custodial accessories.
4. Grab bar.
5. Liquid Soap dispenser.
6. Towel bar.
7. Mop and broom holder.
8. Robe hook.
9. Paper Towel Dispenser.

C. Related Sections: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01340, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Product Data: Manufacturer's technical data and installation instructions for each toilet accessory.

1.03 QUALITY ASSURANCE

A. Inserts and Anchorages: Furnish inserts and anchoring devices which must be set in concrete or built into masonry; coordinate delivery with other work to avoid delay.

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

C. Accessory Locations: Coordinate accessory locations with other work to avoid interference and to assure proper operation and servicing of accessory units.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Toilet and Bath Accessories:

a. A&J Washroom Accessories.
b. American Specialties, Inc.
c. Bobrick Washroom Equipment, Inc.
d. Bradley Corporation.
e. Franklin Brass Manufacturing Co.
f. McKinney/Parker, Inc.
g. Georgia Pacific

2.02 MATERIALS

A. Stainless Steel: AISI Type 302/304, with polished No. 4 finish, 22 gauge (0.034 inch) minimum, unless otherwise indicated.

B. Chromium Plating: Nickel and chromium electro-deposited on base metal, ASTM B 456, Type SC 2.

C. Mirror Glass: FS DD-G-451, Type I, Class 1, Quality q2, 1/4-inch thick, with silver coating, copper protective coating, and non-metallic paint coating complying with FS DD-M-411.

D. Galvanized Steel Mounting Devices: ASTM A 153, hot-dip galvanized after fabrication.

E. Fasteners: Screws, bolts, and other devices of same material as accessory unit or of galvanized steel where concealed.

2.03 PAPER TOWEL DISPENSERS

A. Surfaced-Mounted Towel Dispensers: Basis of Design: Sofpull Regular Capacity Centerpull Paper Tower Dispenser by Georgia Pacific. Color: As selected from manufacturer’s full range of standard colors..

B. Location: Provide one in every toilet room, unless otherwise indicated.

2.04 TOILET TISSUE DISPENSERS

A. Roll-In-Reserve Dispenser: Fabricate of stainless steel for mounting indicated below, sized to store and dispense either 4-1/2-inch-diameter or 5-inch-diameter core tissue rolls, with reserve roll placed in service by automatic release or by action of manual release bar. Hinge front of unit with pivot hinge and secure with tumbler lockset.

1. Mounting:

a. Surface-mounted, concealed anchorage.

B. Single Roll Dispenser: Size to accommodate core tissue to 5-inch-diameter roll.

C. Fabrication:

1. Fabrication: Noncontrolled delivery with manufacturer’s standard spindle.

D. Location: Provide one at each toilet unless otherwise indicated.

2.05 WASTE RECEPTACLES

A. Surface-Mounted Waste Receptacle: Fabricate of stainless steel with seamless exposed walls and continuously welded bottom pan. Furnish heavy-duty vinyl removable liner, secured to receptacle at not less than 4 points by means of grommets and stainless steel hooks; minimum 20.0-gallon capacity.

2.06 GRAB BARS

A. Stainless Steel Type: The grab bars shall meet the requirements as set forth by the State of Florida for making facilities accessible for the physically handicapped. Provide grab bars with wall thickness not less than 18 gauge (0.050-inch), 48 inches long, and as follows:

1. Mounting: Concealed, manufacturer's standard flanges and anchorages.

2. Clearance: 1-1/2-inch clearance between wall surface and inside face of bar.

3. Gripping Surfaces: Smooth, satin finish.

B. Location: Provide 2 at each toilet unless otherwise indicated.

2.07 SOAP DISPENSERS

A. Liquid Soap Dispenser, Horizontal Tank Type: Fabricate for surface mounting, sized for 40-fluid ounce minimum capacity. Provide stainless steel piston, springs, and internal parts designed to dispense soap in measured quantity by pump action. Provide cover, Type 304 stainless steel, with unbreakable window-type refill indicator.

1. Equip unit with push type valve for dispensing soap in liquid form.

B. Location: Provide 1 in each toilet room unless otherwise indicated.

2.08 MISCELLANEOUS ACCESSORIES

A. Mop and Broom Holder/Utility Shelf (MBH/US): Combination unit with 18 gauge (0.050 inch), Type 304 stainless steel shelf with 1/2-inch returns and 16 gauge (0.062 inch) support brackets for wall mounting. Provide 16-gauge stainless steel hooks for wiping rags on front of shelf, together with spring-loaded rubber cam type mop/broom holders and 1/4-inch-diameter stainless steel drying rod suspended beneath shelf. Provide 36-inch-long unit with 4 mop/broom holders and 3 hooks.

1. Location: Provide 1 in each janitor closet unless otherwise indicated.

2.09 FABRICATION

A. Only an unobtrusive stamped logo of manufacturer, as approved by ENGINEER, is permitted on exposed face of toilet or bath accessory units. On either interior surface not exposed to view or back surface, provide additional identification by means of either a printed, waterproof label or a stamped nameplate indicating manufacturer's name and product model number.

B. Surface Mounted Toilet Accessories, General: Except where otherwise indicated, fabricate units with tight seams and joints and exposed edges rolled. Hang doors or access panels with continuous stainless steel piano hinge. Provide concealed anchorage wherever possible.

C. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install toilet accessory units in accordance with manufacturer’s instructions using fasteners which are appropriate to substrate and recommended by manufacturer of unit. Install units plumb and level, firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F 446.

3.02 ADJUSTING AND CLEANING

A. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.

B. Clean and polish all exposed surfaces after removing temporary labels and protective coatings.

END OF SECTION

DIVISION 11

NOT USED

DIVISION 12

NOT USED

DIVISION 13

SPECIAL CONSTRUCTION

SECTION 13300

INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. The Contractor shall furnish, install and place into service operating process instrumentation, control systems and panels including accessories, related to this facility, all as shown on plans and specified herein. The plans and specifications are not intended to show every detail of the requirements. The System includes all materials, labor, tools, fees, charges and documentation required to furnish, install, test and place in operation a complete and operable instrumentation, control and information system as shown and/or specified. The system shall include all measuring elements, signal converters, transmitters, local control panels, digital hardware and software, computer systems, interface terminals, signal and data transmission systems, interconnecting wiring and such accessories as shown, specified, and/or required to provide the functions indicated.

1. Existing plant systems must remain operational during construction.

2. Functioning equipment present in these panels must remain functional and will be included on the instrument contractor's "As-Built" drawings. No existing equipment, with the exception of the field wires and panel, may be reused as part of the new control system. New power supplies, surge suppressors, terminal strips, etc. for all I/O to be connected to the new control system must be provided new. The instrument contractor is responsible to provide completed panels that are clean, functional and present a professional workman-like appearance.

3. All wires in control panels must be permanently tagged and shown on the as-built drawings. This includes all spare and abandoned wires and cables. Spare and abandoned cables are to be taped and left coiled in the panels for future use. Cable and wire numbers are to be assigned by the contractor, documented and controlled to prevent duplicate numbers. The contractor shall turn over to the owner, at the project conclusion, a cable and wire list showing assigned numbers and their physical location in the plant.

4. See electrical drawings and specifications for additional work required of the instrument contractor as part of this project to supply demolition instructions, relocation and modification instructions for equipment not necessarily shown on the instrument drawings.

5. Contractor shall modify the existing PLC system, SCADA screens, and report generation requirements at the existing Western Regional Plant to include all the proposed modifications as part of this project and as stated in this specification. Contractor shall update the iFIX database.

B. Work Includes: Engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and OWNER training for a complete Instrumentation and Control System.

Major parts are:

1. New Network Cabinet.
2. Modification of network communication to place new fire alarm system and new access control system of Maintenance Building into the existing communication system.
3. Modification of existing HYPO PLC control panel.

C. Instrument and Control (I&C) Contractor work scope:

1. For I&C equipment and ancillaries provide the following:

   a. Completing detail design.
   b. Required Submittals.
   c. Equipment and ancillaries.
   d. Instructions, details, and recommendations to, and coordination with, Contractor for proper installation.
   e. Verify readiness for operation.
   f. Verify the correctness of final power and signal connections.
   g. Adjusting and calibrating.
   h. Testing and coordination of testing.
   i. Training.

2. Verify following work not by I&C Contractor is provided:

   a. Correct type, size, and number of signal wires with their raceways.
   b. Correct electrical power circuits and raceways.
   c. Correct size, type, and number of I&C related pipes, valves, fittings, and tubes.
   d. Correct size, type, materials, and connection of process mechanical piping for in-line primary elements.

3. For equipment not provided under I&C Contractor, but directly connected to equipment required by I&C Contractor:

   a. Obtain from Contractor, manufacturer's information on installation, interface, function, and adjustment.
   b. Coordinate with Contractor to allow required interface and operation with I&C System.
   c. For operation and control, verify that installations, interfacing signal terminations, and adjustments have been completed with manufacturer's recommendations.

d. Test to demonstrate required interface and operation with I&C System.
e. Examples of items in this category, but not limited to the following:
   1) Valve operators, position switches, and controls.
   2) Chemical feed pump and feeder speed/stroke controls.
   3) Automatic samplers.
   4) Motor control centers.
   5) Adjustable speed drive systems.
f. Examples of items not in this category:
   1) Internal portions of equipment provided under Division 16, Electrical, that are not directly connected to equipment under I&C System.
   2) Internal portions of I&C Systems provided as part of package systems and that are not directly connected to equipment provided under I&C System.

4. Wiring external to equipment provided by I&C Contractor:

   Special control and communications cable: Provided by I&C Contractor.

D. Software Engineering work scope:

1. Configuration of PLCs, including:
   a. Correct I/O mapping and scaling.
   b. Ladder logic implementing defined control strategies.
   c. SCADA interface mappings.
   d. Specifications/documents including: System External Specification, System Internal Specification, I/O Checklist, Factory Acceptance Test Plan, and Site Acceptance Test Plan.
   e. As-built documentation

2. Start-up support, including system testing.

3. System training.

4. Computer based SCADA system (Proficy HMI/SCADA - iFIX). Coordinate with Owner for County's standard current version and provide accordingly.

1.02 SINGLE INSTRUMENT CONTRACTOR

A. The Contractor shall assign to the Single Instrument and Control (I&C) System Integrator full responsibility for the functional operation of all new instrumentation systems. The Contractor shall have said Integrator perform all engineering necessary in order to select, to furnish, to program, to supervise installation, connection, to calibrate, to place into operation of all sensors,

instruments, alarm equipment, control panels, accessories, and all other equipment as specified herein. The I&C integrator shall have a maintenance office within a 150 mile radius of the project.

B. The single instrument and controls integrator shall demonstrate his ability to successfully complete projects of similar sizes and nature. Provide references (including phone number and contact name) for at least three projects successfully completed in which the following tasks were performed: system engineering, documentation including panel assembly, schematics and wiring diagram, programming, field testing, calibration and start-up, operator instruction and maintenance training.

The foregoing shall enable the Contractor and the Owner to be assured that the full responsibility for the requirements of this Section shall reside in an organization which is qualified and experienced in the water management field and its process technology on a functional systems basis.

The single I&C integrator shall have a UL approved shop and shall build all panels according to UL 508A. The single I&C integrator shall be corning certified contractor.

Instrumentation and Controls System Integrator shall be **Curry Controls or Revere Control, "No approved equal"**.

C. The single software engineering shall demonstrate his ability to successfully complete projects of similar sizes and nature. Provide references (including phone number and contact name) for at least three projects successfully completed in which the following tasks were performed: ladder logic programming, computer based SCADA system configuration, documentation, field testing, start-up, and operator instruction.

1.03 INSTALLATION WORK

A. Nothing in this part of the Specifications shall be construed as requiring the Contractor to utilize personnel supplied by his assigned instrument manufacturer's organization, or any division thereof, to accomplish the physical installation of any elements, instruments, accessories or assemblies specified herein. However, the Contractor shall employ installers who are skilled and experienced in the installation and connection of all elements, instruments, accessories and assemblies; portions of their work shall be supervised or checked as specified in Part 3, herein.

1.04 PREPARATION OF SUBMITTAL OF DRAWINGS AND DATA

A. It is incumbent upon the Contractor to coordinate the work specified in these Sections so that a complete I&C system for the facility shall be provided and shall

be supported by accurate Shop and record Drawings. As a part of the responsibility as assigned by the Contractor, the Single I&C Integrator shall prepare and submit through the Contractor, complete organized Shop Drawings, as specified in Part 2.02, herein. Interface between instruments, motor starters, etc. shall be included in his Shop Drawing submittal.

A. During the period of preparation of this submittal, the Contractor shall authorize direct, informal liaison between his Single I&C Contractor, I&C System Integrator/ I&C software engineer and the Engineer for exchange of technical information. As a result of this liaison, certain minor refinements and revisions in the systems as specified may be authorized informally by the Engineer, but these shall not alter the scope of work or cause increase or decrease in the Contract Price. During this informal exchange, no oral statement by the Engineer shall be construed to give formal approval of any component or method, nor shall any statement be construed to grant formal exception to, or variation from these Specifications.

C. In addition, I&C integrator/ software programmer shall also provide fully documented version of PLC programming and HMI programming on the CD and hard paper copy.

D. Submit detailed drawings covering control consoles which shall include, scaled layout drawings, cabinet dimensions and location, fabrication and painting specifications, color selection samples for selection by the Owner, and all other equipment and mounting cut sheets.

E. Provide an example of tagging style for PLC and SCADA system shall be submitted. If new SCADA screens are needed as part of the project, provide SCADA screens during submittal.

1.05 ADDITIONAL TECHNICAL SERVICES

A. At no separate additional cost to the Owner, the Contractor shall provide the following services of qualified technical representatives of the Single I&C Integrator (See Part 3, herein).

1. To supervise installation and connection of all instruments, elements, and components of every system, including connection of instrument signals to primary measurement elements and to final control elements such as pumps, valves, and chemical feeders;

2. To make all necessary adjustments, calibrations and tests; and

3. To instruct plant operating and maintenance personnel on instrumentation. This time shall be in addition to whatever time is required for other facets

of work at the site, and shall be during the Owner's normal working days and hours.

4. To terminate and test all fiber optic cable and effected devices. Submit report copies of fiber testing and findings after fiber optic testing is completed.

1.06 GUARANTEE

A. The Contractor shall guarantee all equipment and installation, as specified herein, for a period of one (1) year following the date of completion of the work. To fulfill this obligation, the Contractor shall utilize technical service personnel designated by the Single I&C System Integrator to which the Contractor originally assigned project responsibility for instrumentation. Services shall be performed within two (2) calendar days after notification by the Owner.

1.07 ADDITIONAL PROVISIONS

A. The applicable provisions of the following Sections under Electrical Work shall apply to work and equipment specified herein, the same as if stated in full, herein:

1. Codes and Standards
2. Equipment, Materials and Workmanship
3. Testing
4. Grounding
5. Equipment Anchoring
6. Conductor and Equipment Identification
7. Terminal Cabinets and Control Compartments
8. Process Control Devices

1.08 NEWEST MODEL COMPONENTS

A. All meters, instruments, and other components shall be the most recent field proven models marketed by their manufacturers at the time of submittal of Shop Drawings unless otherwise specified to match existing equipment. All technical data publications included with submittals shall be the most recent issue.

1.09 INSPECTION OF THE SITE AND EXISTING CONDITIONS

A. The instrumentation drawings were developed from past record drawings and information supplied by the OWNER.

B. Before submitting a bid, visit the site and determine conditions at the site and at all existing structures in order to become familiar with all existing conditions and instrumentation and control systems which will, in any way or manner, affect the work required under this Contract. No subsequent increase in Contract cost will

be allowed for additional work required because of the CONTRACTOR'S failure to fulfill this requirement.

1.11 RELATED WORK

A. Division 16 - Electrical
B. Division 11 - Equipment
C. Division 13 - Special Construction

PART 2 - PRODUCTS

2.01 INSTRUMENTATION CRITERIA

A. DESIGNATION OF COMPONENTS:

In these Specifications and on the Drawings, all systems, meters, instruments, and other elements are represented schematically, and are designated by numbers, as derived from criteria in Instrument Society of American Standard ANSI/ISA S5.1-1973. The nomenclature and numbers designated herein and on the Drawings shall be employed exclusively throughout Shop Drawings, data sheets, and similar materials. Any other symbols, designations, and nomenclature unique to the manufacturer's standard methods shall not replace these prescribed above, used, herein and on the Drawings.

B. SIGNAL CHARACTERISTICS:

Signals shall be electrical, as indicated herein, and shall vary in direct linear proportion to the measured variable, except as noted. Electrical signals outside control panel(s) shall be 4 to 20 milliamperes DC, except as noted. Signals within enclosures may be 1-5 volts DC.

C. MATCHING STYLE, APPEARANCE AND TYPE:

All instruments to be panel mounted at the control panels shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be of one (1) manufacturer.

D. ACCURACY AND REPEATABILITY:

The overall accuracy of each instrumentation system or loop shall be as prescribed in the Specifications for that system or loop. Each system's accuracy shall be determined as a probable maximum error; this shall be the square-root of the sum of the squares of certified "accuracy s" of certain designated components in each system, expressed as a percentage of the actual span or value of the measured variable. Each individual electronic instrument shall have a minimum accuracy of $\pm$0.7 percent of full scale and a minimum repeatability of $\pm$0.4 percent of full scale

unless otherwise specified. Instruments which do not conform to or improve upon these criteria are not acceptable.

2.02 DETAILED SYSTEMS DRAWINGS AND DATA

A. CONTENT:

The Contractor shall submit detailed Shop Drawings and data prepared and organized by the Single I&C System Integrator designated at the time of bidding. The quantity of submittal sets required shall be six (6). These Drawings and data shall be submitted as a complete bound package at one time within 80 calendar days after date of Notice to Proceed and shall include:

1. Drawings showing definite diagrams for every instrumentation loop system. These diagrams shall show and identify each component of each loop or system using legend and symbols from ISA Standard S5.4, each having the format of ISA Standard S5.1 as used on the Project Drawing. (Each system or loop diagram shall be drawn on a separate Drawing sheet.)

2. Data sheets for each component, together with a technical product brochure or bulletin. The data sheets shall show:

    a. Component function description used herein and on the Drawings;
    b. Manufacturer's model number or other product designation;
    c. Project tag number used herein and on the Drawings;
    d. Project system loop of which the component is a part;
    e. Project location or assembly at which the component is to be installed;
    f. Input and output characteristics;
    g. Scale range and units (if any) and multiplier (if any);
    h. Requirements for electric supply (if any);
    i. Requirements for air supply (if any);
    j. Materials of component parts to be in contact with, or otherwise exposed to, process media;
    k. Calibration curves as required.
    l. Special requirements or features.

    A complete index shall appear in the front of each bound submittal volume. A separate technical brochure or bulletin shall be included with each instrument data sheet. The data sheets shall be indexed in the submittal by systems or loops, as a separate group for each system or loop. If, within a single system or loop, a single instrument is employed more than once, one data sheet with one brochure or bulletin may cover all identical uses of that instrument in that system. Each brochure or bulletin

shall include a list of tag numbers for which it applies. System groups shall be separated by labeled tags.

3. Drawings showing both schematic and wiring diagrams for control circuits. Complete details on the circuit interrelationship of all devices within and outside each control panel shall be submitted first, using schematic control diagrams. Subsequent to return of this first submittal by the Engineer, piping and wiring diagrams shall be prepared and submitted for review by the Engineer; the diagrams shall consist of component layout Drawings to scale, showing numbered terminals on components together with the unique number of the wire to be connected to each terminal. Piping and wiring diagrams shall show terminal assignments from all primary measurement devices, such as flow meters, and to all final control devices, such as samplers, pumps, valves, and chemical feeders. The Contractor shall furnish all necessary equipment supplier's Shop Drawings to facilitate inclusion of this information by the I&C System Integrator.

   Schematic and wiring diagram criteria shall be followed as established in NEMA Standards Publication ANSI/NEMA 1CS-1-1978, "Industrial Control and Systems."

4. Assembly and construction Drawings for each control panel and for other special enclosed assemblies for field installation. These Drawings shall include dimensions, identification of all components, surface preparation and finish data, nameplates, and the like. These Drawings also shall include enough other details, including prototype photographs, to define exactly the style and overall appearance of the assembly; a finish treatment sample shall be included.

5. Installation, mounting and anchoring details for all components and assemblies to be field-mounted, including conduit connection or entry details.

6. Complete and detailed bills of materials. A master Bill of Materials listing all field mounted devices, control panels and other equipment that shall be shipped to the job site. A Bill of Materials for each control panel listing all devices within the panel.

7. Modifications to existing equipment. A complete description of all proposed modifications to existing instrumentation equipment, control panels, control devices, cabinets, etc., shall be submitted with the Shop Drawings complete with detailed Drawings of the proposed modifications.

B. ORGANIZATION AND BINDING:

The organization of initial Shop Drawing submittal required above shall be compatible to eventual inclusion with the Technical Manuals submittal and shall

include final alterations reflecting "as built" conditions. Accordingly, the initial multiple copy Shop Drawing submittal shall be separately bound in 3-ring binders of the type specified under Part 2.03, herein, for the Technical Manuals.

2.03 TECHNICAL MANUALS

A. Five (5) final sets of technical manuals shall be supplied for the Owner, and one (1) final set shall be supplied for the Engineer, as a condition of acceptance of the project. Each set shall consist of one (1) or more volumes, each of which shall be bound in a standard size, three-ring, loose-leaf, vinyl plastic hard cover binder suitable for bookshelf storage. Binder ring size shall not exceed 3.0 inches.

B. Initially, two (2) sets of these manuals shall be submitted to the Engineer for favorable review after return of favorably reviewed Shop Drawings and data required under Part 3, herein. Following the Engineer's review, one (1) set shall be returned to the Contractor with comments. The sets shall be revised and/or amended as required and the requisite final sets shall be submitted to the Engineer fifteen (15) days prior to start-up of systems. The Engineer shall distribute the copies.

B. In addition to updated Shop Drawing information to reflect actual existing conditions, each set of technical manuals shall include installation, connection, operating, trouble-shooting, maintenance, and overhaul instructions in complete detail. This shall provide the Owner with comprehensive information on all systems and components to enable operation, service, maintenance, and repair. Exploded or other detailed views of all instruments, assemblies, and accessory components shall be included together with complete parts lists and ordering instructions.

C. Contractor shall also need to provide all technical manuals and shop drawing information in electronic format (pdf, MS words, AutoCAD, etc.) and combine in a CD or DVD. Provide two copies of CD or DVD with the hard copies as stated above.

2.04 MODIFICATION OF EXISTING PLC CONTROL PANELS

A. SIGNAL AND CONTROL CIRCUIT WIRING:

1. WIRE TYPE AND SIZES

Conductors shall be flexible stranded copper wire; these shall be U.L. listed Type THHN and shall be rated 600 volts. Wire for control signal circuits and alarm input circuits shall be 16 AWG. All instrumentation cables shall be shielded twisted pair or triad No. 20 AWG with a copper drain wire. Multiconductor control cabling shall not be used. All special instrumentation cable such as between sensor and transmitter shall be supplied by the I&C System Integrator. Ethernet cable shall be Category

5e (Enhanced) or Category 6, as shown. Refer to specification 16120 for Category 6 cable specification.

2. WIRE INSULATION COLORS

Conductors supplying 120 volt AC power on the line side of a disconnecting switch shall have a black insulation for the ungrounded conductor. Grounded circuit conductors shall have white insulation. Insulation for ungrounded 120 volt AC control circuit conductors shall be red. All wires energized by a voltage source external to the control board(s) shall have yellow insulation. Insulation for all DC conductors shall be blue.

3. WIRING INSTALLATION

All wires shall be run in plastic wireways except (1) field wiring, (2) wiring run between mating blocks in adjacent sections, (3) wiring run from components on a swing-out panel to components on a part of the fixed structure, and (4) wiring run to panel mounted components. Wiring run from components on a swing-out panels to other components on a fixed panel shall be made up in tied bundles. These shall be tied with nylon wire ties, and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at terminals.

Wiring run to control devices on the front panels shall be tied together at short intervals with nylon wire ties and secured to the inside face of the panel using adhesive mounts.

Wiring to rear terminals on panel mount instruments shall be run in plastic wireways secured to horizontal brackets run above or below the instruments in about the same plane as the rear of the instruments.

Shields of shielded instrument cable shall only be grounded on one side of each cable run. The side to be grounded shall always be in the field as applicable.

Care shall be exercised to properly insulate the ungrounded side, to prevent ground loops from occurring.

Conformance to the above wiring installation requirements shall be reflected by details shown on the Shop Drawings for the Engineer's review.

4. WIRE MARKING

Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which

shall be shown on all Shop Drawings. These numbers shall be marked on all conductors at every terminal using permanently marked heat-shrink plastic. Instrument signal circuit conductors shall be tagged with unique multiple digit numbers. Black and white wires from the circuit breaker panelboard shall be tagged including the one (1) or two (2) digit number of the branch circuit breaker. Adhesive wire labels are not acceptable.

5. TERMINAL BLOCKS

Terminal blocks shall be molded plastic with barriers and box lug terminals, and shall be rated 15 amperes at 600 volts. White marking strips, fastened securely to the molded sections, shall be provided and wire numbers or circuit identifications shall be marked thereon with permanent marking fluid. Terminal blocks shall be General Electric Type CR 151A1 with mounting rack, equivalent by Cinch-Jones or equal.

6. TERMINATION OF WIRING

All PLC I/O wiring shall be terminated on removable terminal strips on the individual PLC modules that permit removing I/O modules without disconnecting the wiring. Tag and mark all terminal blocks and individual wiring. All wiring from the field shall terminate on a separate numbered terminal blocks. Separate groups of terminal blocks in discrete inputs, discrete outputs, analog inputs, analog outputs, each different voltages, UPS power, etc. Use different colored wire for all digital inputs and digital outputs to aid in easy identification of signal type.

7. FIBER OPTIC CABLE

New and replaced fiber shall be 12 strings (6-pairs) Corning 62.5 multimode fiber optic. Label each end of the fiber optic cables according with County's standards. All fiber optic cable, including spares, shall be terminated or spliced in fiber optic patch panels. Provide patch cables as required. All patch panel indoors shall be provided with NEMA 12 enclosures, all panels outdoors shall be located in NEMA 4X enclosures and shall handle at least 12 strings (6-pairs) of fiber. Corning is an acceptable fiber optic cable manufacturer and shall provide a 25 year warranty on fiber cable. Fiber optic cable shall be installed by a Corning certified I&C installer with a 25 year warranty guarantee for the Owner/County.

B. PLC CONTROL PANEL MODIFICATIONS

Refer to Instrumentation Drawings for modification of the existing HYPO PLC control panel to include new signals as shown. Contractor shall perform I/O mapping for new signals.

2.05 ACCESSORIES

A. General purpose relays with LED indication in the control panels shall be plug in type with contacts rated 10 amperes at 120 volts AC. The quantity and type of contacts shall be as shown on the Drawings. Each relay shall be enclosed in a clear plastic heat and shock resistant dust cover. Sockets for relays shall have screw type terminals. Relays shall be Potter and Brumfield Type KRP or KUP, Square-D Type K, or equal.

B. Time delay relays shall be solid state on-delay or off-delay type with contacts rated 10 amperes at 120VAC. Units shall include adjustable dial with graduated scale or digital switch setting covering the time range in each case. Time delay relays shall be Agastat Series 7000, Omron series H3, SSAC type TDM or approved equal.

C. Additional slave relays shall be installed when the number or type of contacts shown exceed the contact capacity of the specified relays and timers.

D. All relays shall be provided with LED indication and a test button to show when relay is energized. Relays shall be mechanically latched type where the service is primarily in the hold open or hold closed position to maintain the operating function. Internal intermittent acting relays may be electrically held. Fail safe conditions may also utilize electrically held relays.

E. Switches shall be round 30.5mm configuration and LED indicating lights shall be round 16 mm configuration, heavy duty and corrosion resistant. Legend plate shall be standard size square style laminate with white field and black markings as shown.

F. LED Indicating lights (Pilot lights) shall be rated oil tight/water tight, heavy duty. Miniature type devices are not acceptable. Pilot lights shall be of the transformer type utilizing low voltage lamps. Pilot lights shall be either the push to test type or a common lamp test button type provided on the panel. Pilot lights shall allow for lens and bulb replacement through the front of the unit. Pilot light shall be new LED technology type, no exception. Pushbuttons shall include full guard with flush button and selector switches shall include a black non-illuminated knob on switch, unless otherwise noted. Contact arrangement and configuration shall be as shown on drawings. Devices shall be Cutler Hammer Type E-30, General Electric Type CR104, Square D class 9001 type Sk, Allen Bradley Bulletin 800 or equal.

G. Selector switches shall be of the rotary type with the number of positions as shown on the Drawings. Color, escutcheon engravings, contact configurations and the like shall be as shown. Devices shall be Cutler Hammer Type E-24, General Electric Type CR104, or equal.

H. Circuit breakers shall be single pole, 120 volt, 15 ampere rating or as required to protect wires and equipment and mounted inside the panels as shown.

I. Nameplates shall be supplied for identification of all field mounted elements, including flow meters and their transmitters. These nameplates shall identify the instrument, or meter, descriptively, as to function and system. These nameplates shall be fabricated from black-face, white-center, laminated engraving plastic. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, each electronic trip, and the like, mounted inside the control panels. These shall be descriptive, to define the function and system of such element. Adhesives shall be acceptable for attaching nameplates. Painted surfaces must be prepared to allow permanent bonding of adhesives. Nameplates shall be provided for instruments, function titles for each group of instruments and other components mounted on the front of the control panels as shown. These nameplates and/or individual letters shall be fabricated from VI-LAM, Catalog No. 200, manufactured by N/P Company, or equivalent by Formica, or equal. Colors, lettering, style and sizes shall be as shown or as selected by the Engineer.

2.06 CONTROL STRATEGY SCHEDULES

The I&C Software Engineer shall include an additional 8 hours on-site to fine tune control systems and make minor software modifications in order to resolve any logic discrepancies encountered during start-up, and supply the Owner with a complete functional system. This shall be part of the bid package with no additional cost to the owner.

New door contact signals shall be programmed to notify the operator on SCADA screens when the door is opened. The alarm condition shall go away when the door is closed.

2.07 NETWORK CABINET

A. Provide a cabinet for fiber optic patch panel. Cabinet shall provide security, equipment access, cooling, and support for network switch and other rack-mount equipment. Owner will furnish the rack mounted network switch to the Contractor to be installed in the network cabinet.

B. Enclosure type: Type 1, back wall mount.

C. Provide power strip “Tripp-Lite” or equal in the cabinet.

D. Front Door (Window) with 140-degree opening. Field reversible (left or right) hinge. Quarter-turn key lock.

E. Ventilated front and sides (no fan is needed). Side panels can be removed or opened.

F. Self-latching closure connects center section to wall section and rack mounting angles.

G. Finish: pretreated steel coated with RAL 9005 black light-textured, low-gloss polyester powder paint.

H. Minimum 12U. Maximum dimension of enclosure shall be 25.1" x 23.6" x 33.5"H.

I. Provide 120V power strip (1U) in the enclosure.

J. Furnish Network cabinet with 1U 24 port ethernet copper punch down assembly.

K. Owner (Orange County Utilities) will provide Cisco Catalyst network switch. Coordinate with Owner for minimum number of ports required for this project. Provide and install all necessary SFP transceivers and patch cables.

L. Manufacturer:
1. Hoffman/Penair,
2. Tripp-Lite,
3. Or Owner approved equal.

PART 3--EXECUTION

3.01 INSTALLATION, CALIBRATION, TESTING, START-UP AND INSTRUCTION

A. GENERAL:

Under the supervision of the Single I&C Contractor, all systems specified in this Section shall be installed, connected, calibrated and tested, and in coordination with the Engineer and the Owner, shall be started to place the processes in operation. This shall include final calibration in concert with equipment specified elsewhere in these Specifications, including pumps, valves, as well as certain existing equipment.

B. TESTING

All systems shall be exercised through operational tests in the presence of the Engineer in order to demonstrate achievement of the specified performance. Operational tests depend upon completion of work specified elsewhere in these Specifications. The scheduling of tests shall be coordinated by the Contractor among all parties involved so that the tests may proceed without delays or disruption by incomplete work.

See section 3.03 supplements for sample "Loop Status Report" and "Functional Acceptance Test Sheet".

C. INSTALLATION AND CONNECTION:

1. The Contractor shall install and connect all field-mounted components and assemblies under the criteria imposed in Part 1, 1.03, herein. The installation personnel shall be provided with a final reviewed copy of the Shop Drawings and data.

2. The instrument process sensing lines and air signal tubing shall, in general, be installed in a similar manner to the installation of conduit specified under Section 16110. Individual tubes shall be run parallel and near the surfaces from which they are supported. Supports shall be used at intervals of not more than 3 feet of rigid tubing.

3. Bends shall be formed with the proper tool and to uniform radii and shall be made without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square cut and cleaned before being inserted in the fittings. Bulkhead fittings shall be provided at all panels.

4. The Contractor shall have a technical field representative of the I&C System Integrator to instruct these installation personnel on any and all installation requirements; thereafter, the technical field representative shall be readily available by telephone to answer questions and supply clarification when needed by the installation personnel.

5. Where primary elements (supplied by I&C Contractor) shall be part of a mechanical system, the I&C Contractor shall coordinate the installation of the primary elements with the mechanical system manufacturer.

6. Fiber Optic Installation:

   a. Fiber optic cable shall be furnished by the I&C System Integrator and installed by the Corning certified I&C provider with a 25 year warranty guarantee. The I&C System Integrator shall provide the services of an experienced fiber optic cable terminator and tester. The I&C System Integrator shall supervise the cable installation and shall carry out all terminations at the I/O racks, repeaters, and data concentrators at PLC's and computers. Fiber optic cable termination shall be carried out using the appropriate connectors and termination kit. All fiber optic system components shall be products of one manufacturer.

   b. Fiber optic cable system shall be designed to minimize cable splicing. Where splicing becomes necessary perform fusion splice with loss not to exceed 0.2 dB. Test all splices with an Optical Time Domain

Reflectometer (ODTR) bi-directionally to verify splice loss at the time of splicing. Redo any splices not conforming to Specifications. Provide means to protect the unspliced portions of the cable from intrusion of moisture and other foreign matter. Identify required splices in the submittal. Splices not identified in the submittal shall not be acceptable unless approved by the ENGINEER.

c. After the fiber optic data link is in place, test the attenuation from hub to hub bi-directionally and document test results. Attenuation in excess of 3.5 dB/km at 850 nm wavelength or 1.0 dB/km at 1300 nm wavelength shall require the I&C System Integrator to replace the defective sections and retest until the attenuation is below the attenuation allowed per kilometer at the wavelengths cited.

d. The I&C System Integrator is responsible for the satisfactory performance of all fiber optic data links. Demonstrate and document error free bi-directional data files transfer from each host computer to each PLC node.

7. Finally, after all installation and connection work has been completed, the technical field representative shall check it all for correctness, verifying polarity of electric power and signal connections, making sure all process connections are free of leaks, and all such similar details. If the initial inspection finds no deficiencies, the technical field representative shall proceed to the certification to the Contractor. Any completed work that is found to have deficiencies shall have those deficiencies corrected by installation personnel at no additional cost to the Owner. The technical field representative shall then recheck the work after the identified deficiencies are corrected. If the technical field representative finds deficiencies in the follow-up inspection, then remedial action shall be taken by the Contractor at no cost to the Owner. This pattern shall be repeated until the installation is free from defect. The technical field representative shall then certify in writing to the Contractor that for each loop or system that he has inspected is complete and without discrepancies.

8. The field representative of the Single I&C System Integrator shall coordinate all work required to interface the new equipment and control devices with the existing equipment, including all required modifications to existing equipment and related devices.

D. PRE-COMMISSIONING

The I&C System Integrator shall test each loop (discrete and analog) to determine if it is functioning correctly. The I&C System Integrator shall furnish a loop sheet for each loop to be tested. The loop sheet shall represent the actual “as-built” condition of the loop. The I&C System Integrator shall perform a field functional

loop test which shall be witnessed by the ENGINEER and OWNER. If the loop fails the functional test, the I&C System Integrator shall coordinate repairs for the CONTRACTOR to correct whatever is wrong with the loop. The I&C System Integrator shall retest the loop until it is approved.

E. MODIFICATIONS TO EXISTING FACILITIES

The Contractor shall make all modifications to existing equipment and control devices which are required to successfully install and integrate all new instrumentation equipment. All costs for any required modification and rehabilitation effort shall be included in the Contractor's original bid amount and no additional payment shall be allowed.

F. COORDINATION WITH OTHER CONCURRENT PROJECTS

The I&C Contractor shall coordinate extensively with other I&C Contractors of concurrent projects. Some of the equipment shown in this contract as existing might be installed while this contract is underway.

3.02 TRAINING

A. General:

1. Provide an integrated training program to meet specific needs of Owner’s personnel.

2. Provide instruction on one working shift as needed to accommodate the Owner’s personnel schedule.

3. Owner reserves the right to make and reuse video tapes, CD’s of training sessions if applicable.

B. Operations and Maintenance Training:

1. Include a review of O&M manuals, expendables, and test equipments.

2. Training session duration shall be minimum 4 hours. Provide training schedule with outlines at least one week before the training to the Owner.

3. Training shall include a minimum understanding of loop functions, loop operation, component calibration, adjustments such as controller tuning, switch trip point, etc., and periodic maintenance.

3.03 SUPPLEMENTS

A. Supplements listed below, following "END OF SECTION" are part of this Specification.

1. Instrumentation Calibration Sheet
2. Loop Status Report
3. Functional Acceptance Test Sheet

END OF SECTION

LOOP STATUS REPORT

PROJECT NAME:_____

PROJECT NO.:_____

FUNCTIONAL REQUIREMENTS

COMPONENT STATUS

TAG NO.	DELIVERED*	TAG/IDENTIFI-CATION CHECK*	INSTALLATION CHECK	TERMINATION WIRING*	TERMINATION TUBING*	CALIBRATED*

REMARKS

LOOP READY FOR START-UP

BY

DATE

* INITIAL AND DATE WHEN COMPLETE

FUNCTIONAL ACCEPTANCE TEST SHEET

PROJECT NAME: _____

PROJECT NO. :

FUNCTIONAL REQUIREMENTS AND
SUMMARY OF COMPONENTS:
(ATTACH XEROX OF LOOP SPECIFICATION FROM THE CONTRACT DOCUMENTS)

VERIFICATION OF LOOP STATUS REPORT AND BY:_____

INSTRUMENT AND VALVE CALIBRATION SHEETS DATE:_____

DEMONSTRATION TEST(S): FOR EACH FUNCTIONAL REQUIREMENT OF THE LOOP:

REQUIRED PERFORMANCE

(a) LIST AND NUMBER THE REQUIREMENT

(b) BRIEFLY DESCRIBE THE DEMONSTRATION TEST

(c) CITE THE RESULTS THAT WILL VERIFY THE

(d) PROVIDE SPACES FOR INITIAL AND DATE OF TEST WITNESS.

PERFORMED BY: WITNESSED BY: COMPLETED DATE:	LOOP ACCEPTED BY (OWNER) BY DATE
CHECK IF REMARKS ON REVERSE SIDE	LOOP NO.

INSTRUMENTATION CALIBRATION SHEET

COMPONENT CODE: NAME:	MANUFACTURER: MODEL: SERIAL:	PROJECT NUMBER: NAME:

	RANGE	VALUE	UNITS	☐COMPUTE	☐ CONTROL ACTION (DIRECT/REVERSE) MODES (P/I/D)
☐INDIATE/ RECORD	CHART	_____	_____	FUNCTIONS	
	SCALE	_____	_____		☐ SWITCH UNIT RANGE (VALUE/UNITS)
☐TRANS/ CONVERT	INPUT	_____	_____		DIFFERENTIAL (FIXED/ADJUSTABLE) RESET (AUTOMATIC/MANUAL)
_____	OUTPUT	_____			

ANALOG							DISCRETE					
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		REMARKS CODE
IN	SCALE	OUT	SCALE	OUT	SCALE	OUT	NUMBER	TRIP PT	RESET PT	TRIP PT	RESET PT	
C. MODE SETTINGS: P			I		D							

	COMPONENT CALIBRATED AND READY FOR START-UP BY DATE
	TAG NO.

DIVISION 14

NOT USED

DIVISION 15

MECHANICAL

SECTION 15000

MECHANICAL-GENERAL
REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. All equipment furnished and installed under this contract shall conform to the general stipulations set forth in this section except as otherwise specified in other sections.

2. Contractor shall coordinate all details of equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. Contractor shall be responsible for all structural and other alternations in the Work required to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

B. Related Work Described Elsewhere:

1. General Requirements: Division 1

2. Concrete: Division 3

3. Metals: Division 5

4. Painting: Division 9

5. Equipment: Division 11

6. Special Construction: Division 13

7. Electrical: Division 16

C. General Design:

1. Contract Drawings and Specifications: The Contract Drawings and Specifications shall be considered as complementary, one to the other, so that materials and work indicated, called for, or implied by the one and not by the other shall be supplied and installed as though specifically called for by both. The Contract Drawings are to be considered diagrammatic, not necessarily showing in detail or to scale all of the equipment or minor items. In the event of discrepancies between the Contract Drawings and Specifications, or between either of these and any regulations or ordinances governing work of these specifications, the bidder shall notify the Engineer in ample time to permit revisions.

1.02 QUALITY ASSURANCE

A. Materials and Equipment: Unless otherwise specified, all materials and equipment furnished for permanent installation in the work shall conform to applicable standards and specifications and shall be new, unused, and undamaged when installed or otherwise incorporated in the work. No such material or equipment shall be used by the Contractor for any purpose other than that intended or specified, unless such use is specifically authorized in writing by the Owner. No material shall be delivered to the work site workout prior acceptance of drawings and data by the Engineer.

B. Where applicable, Manufacturers shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix to these technical specifications.

C. Equivalent Materials and Equipment:

1. Whenever a material or article is specified or described by using the name of a proprietary product or the name of a particular manufacturer or vendor, the specific item mentioned shall be understood as establishing the type, function, and quality desired. Other manufacturers' products will be accepted provided sufficient information is submitted to allow the Engineer to determine that the products proposed are equivalent to those named. Such items shall be submitted for review in accordance with Section 01340: Shop Drawings, Working Drawings, and Samples.

2. Requests for review of equivalency will not be accepted from anyone except the Contractor and such requests will not be considered until after the contract has been awarded.

D. Governing Standards: Equipment and appurtenances shall be designed in conformity with ANSI, ASME, ASTM, IEEE, NEMA, OSHA, AGMA, and other generally accepted applicable standards. They shall be of rugged construction and of sufficient strength to withstand all stresses which may occur during fabrication, testing, transportation, installation, and all conditions or operations. All bearings and moving parts shall be adequately protected against wear by bushings or other acceptable means. Provisions shall be made for adequate lubrication with readily accessible means.

E. Tolerances: Machinery parts shall conform to the dimensions indicated on the drawings within allowable tolerances. Protruding members such as joints, corners, and gear covers shall be finished in appearance. All exposed welds shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.

F. Clearances: Ample clearances shall be provided for inspection and adjustment. All equipment shall fit the allotted space and shall leave reasonable access room for servicing and repairs. Greater space and room required by substituted equipment shall be provided by the Contractor and at his expense.

G. Testing:

1. When the equipment is specified to be factory tested, the results of the tests shall be submitted to the Engineer and approval of the test results shall be obtained before shipment of the equipment.

2. When an item of equipment, including controls and instrumentation, has been completely erected, the Contractor shall notify the Engineer, who will designate a time to make such tests as required, and operate the item to the satisfaction of the Contractor. All testing shall be done in the presence of the Contractor. "Completely erected" shall mean that the installation is erected, all necessary adjustments have been made, all required utility connections have been made, required lubricants and hydraulic fluid have been added and the unit has been cleaned and painted.

H. Pressure Test:

1. After installation, all piping shall be pressure tested. Piping shall be tested in accordance with Section 15044.

2. All tests shall be made in the presence of and to the satisfaction of the Owner and also, to the satisfaction of any local or state inspector having jurisdiction.

   a. Provide not less than three days' notice to the Construction Manager and the authority having jurisdiction when it is proposed to make the tests.

   b. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Construction Manager shall be retested in part or in whole as directed by the Construction Manager.

   c. The piping systems may be tested in sections as the work progresses by no joint or portion of the system shall be left untested.

3. All elements within the system that may be damaged by the testing operation shall be removed or otherwise protected during the operation.

4. All defects and leaks observed during the tests shall be corrected and made tight in an approved manner and the tests repeated until the system is proven tight.

5. Repair all damage done to existing or adjacent work or materials due to or on account of the tests.

6. Provide test pumps, gauges, or other instruments and equipment required for the performance of all tests. Provide all temporary bracing, test plugs, additional restraint, and thrust blocking which may be required for test pressures above normal working pressures.

7. All tests shall be maintained for as long a time as required to detect all defects and leaks but not less than the duration specified for each type of pipe or piping system in this Division.

I. Failure of Test:

1. Defects: Any defects in the equipment, or deviations from the guarantees or requirements of the Specifications, shall be promptly corrected by the Contractor by replacements or otherwise. The decision of the Engineer as to whether or not the Contractor has fulfilled his obligations under the Contract shall be final and conclusive. If the Contractor fails to correct any defects or deviations, or if the replaced equipment when tested shall

fail again to meet the guarantees or specified requirements, the Owner, notwithstanding his having made partial payment for work and materials which have entered into the manufacturer for such equipment, may reject that equipment and order the Contractor to remove it from the premises at the Contractor's expense.

2. Rejection of Equipment: In case the Owner rejects a particular item of equipment, then the Contractor hereby agrees to repay to the Owner all sums of money paid to him to deliver to the Contractor a bill of sale of all his rights, title, and interest in and to the rejected equipment provided, however that the equipment shall not be removed from the premises until the Owner obtains from other sources other equipment to take the place of that rejected. The bill of sale shall not abrogate the Owner's right to recover damages for delays, losses or other conditions arising out of the basic Contract. The Owner hereby agrees to obtain the alternate equipment within a reasonable time and the Contractor agrees that the Owner may use the original equipment furnished by him without rental or other charge until the other equipment is obtained.

J. Responsibility During Tests: The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

K. Acceptance of Materials:

1. Only new materials and equipment shall be incorporated in the work. All materials and equipment furnished by the Contractor shall be subject to the inspection and acceptance of the Owner. No material shall be delivered to the work without prior submittal approval of the Engineer.

2. The Contractor shall submit to the Engineer data relating to materials and equipment he proposes to furnish for the work. Such data shall be in sufficient detail to enable the Engineer to identify the particular product and to form an opinion as to its conformity to the specifications.

3. Facilities and labor for handling and inspection of all materials and equipment shall be furnished by the Contractor. If the Engineer requires, either prior to beginning or during the progress of the work, the Contractor shall submit samples of materials for such special test as may be necessary to demonstrate that they conform to the specification. Such sample shall be furnished, stored, packed, and shipped as directed at the Contractor's expense. Except as otherwise noted, the Owner will make arrangements for and pay for tests.

4. The Contractor shall submit data and samples sufficiently early to permit consideration and acceptance before materials are necessary for incorporation in the work.

L. Safety Requirements:

1. In addition to the components shown and specified, all machinery and equipment shall be safeguarded in accordance with the safety features required by the current codes and regulations of ANSI, OSHA, and local industrial codes.

2. The Contractor shall provide for each V-belt drive or rotating shaft a protective guard which shall be securely bolted to the floor or apparatus. The guard shall completely enclose drives and pulleys and be constructed to comply with all safety requirements.

3. For double inlet fans, the belt guard shall be arranged so as not to restrict the air flow into the fan inlet. Guards shall not interfere with lubrication of equipment.

1.03 SUBMITTALS (SEE SECTION 01340: SHOP DRAWINGS, WORKING DRAWINGS AND SAMPLES)

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Packaging: All equipment shall be suitably packaged to facilitate handling and protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry at all times.

B. Protection: All machined surfaces and shafting shall be cleaned and protected from corrosion by the proper type and amount of coating necessary to assure protection during shipment and prior to installation. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage as specified in Sections 09900 and 09905. A ll painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

C. Lubrication: Grease and lubricating oil shall be applied to all bearings and similar items as necessary to prevent damage during shipment and storage.

D. Marking: Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

E. Fabricated sub-assemblies, if any, shall be shipped in convenient sections as permitted by carrier regulations and shall be properly match-marked for ease of field erection.

F. Responsibility:

1. The Contractor shall be responsible for all material, equipment, and supplies sold and delivered to the site under this Contract until final inspection of the work and acceptance thereof by the Owner. In the event any such material, equipment, and supplies are lost, stolen, damaged, or destroyed prior to final inspection and acceptance, the Contractor shall replace same without additional cost to the Owner.

2. Should the Contractor fail to take proper action on storage and handling of equipment supplied under this Contract within seven days after written notice to do so has been given, the Owner retains the right to correct all deficiencies noted in previously transmitted written notice and deduct the cost associated with these corrections from the Contractor's Contract. These costs may be comprised of expenditures for labor, equipment usage, administrative, clerical, engineering, and any other costs associated with making the necessary corrections.

G. Delivery: The Contractor shall arrange deliveries of products in accordance with construction schedules and coordinate to avoid conflict with work and condition at the site.

1. The Contractor shall deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.

2. Immediately on de livery, the Contractor shall inspect shipments to assure compliance with requirements of Contract Documents and accepted submittals, and that products are properly protected and undamaged.

3. Under no circumstances shall the Contractor deliver equipment to the site more than one month prior to installation without written authorization from the Construction Manager. Operation and maintenance data shall be submitted to the Engineer for review prior to shipment of equipment as described in Section 01730: Operating and Maintenance Data.

H. Storage and Protection of Products:

1. The Contractor shall furnish a covered, weather-protected storage structure providing a clean, dry noncorrosive environment for all mechanical equipment, valves, architectural items, electrical and instrumentation equipment, and special equipment to be incorporated into this project. Storage of equipment shall be in strict accordance with the "Instructions for Storage" of each equipment supplier and manufacturer including connection of space heaters, and placing of storage lubricants in equipment. Corroded, damaged, or deteriorated equipment and parts shall be replaced before acceptance of the project. Equipment and materials not properly stored will not be included in a payment estimate.

    a. The Contractor shall store products subject to damage by the elements in weathertight enclosures.

    b. The Contractor shall maintain temperature and humidity within the ranges required by manufacturer's instructions.

    c. The Contractor shall store fabricated products above the ground, on blocking or skids, to prevent soiling or staining. The Contractor shall cover products which are subject to deterioration with impervious sheet coverings and provide adequate ventilation to avoid condensation.

    d. The Contractor shall store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.

2. All materials and equipment to be incorporated in the work shall be handled and stored by the Contractor before, during, and after shipment in a manner to prevent warping, twisting, bending, breaking, chipping, rusting, and any injury, theft, or damage of any kind whatsoever to the material or equipment.

3. Cement, sand, lime shall be stored under a roof and off the ground, and shall be kept completely dry at all times. All structural and miscellaneous steel and reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt, or grease, and in a position to prevent accumulations of standing water, staining, chipping, or cracking. Brick, block, and similar masonry products shall be handled and stored in a manner to reduce breakage, chipping, cracking and peeling to a minimum.

4. All materials which, in the opinion of the Construction Manager, have become damaged and are unfit for the use intended or specified, shall be promptly removed from the site of the work, and the Contractor shall receive no compensation for the damaged material or its removal.

5. The Contractor shall arrange storage in a manner to provide easy access for inspection. The Contractor shall make periodic inspections of stored products to assure products are maintained under specified conditions, and free from damage or deterioration.

6. Protection After Installation: The Contractor shall provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. The Contractor shall remove covering when no longer needed.

I. Extended Storage Requirements for Equipment: Because of the long period allowed for construction, special attention shall be given to extended storage and handling of equipment onsite. As a minimum, the procedure specified herein shall be followed:

1. If equipment will be stored onsite for more than one month prior to incorporation into the Work, the Contractor shall submit a written request to the Construction Manager outlining any special provision to be made to protect and maintain the equipment while it is being stored. All such provisions shall be acceptable to the Construction Manager. No equipment shall be stored onsite for more than one month without prior written authorization from the Construction Manager.

2. All equipment having moving parts including gears, electric motors, and/or instruments shall be stored in a temperature and humidity controlled building accepted by the Construction Manager, until such time as the equipment is to be installed.

3. All equipment shall be stored fully lubricated with oil and grease unless otherwise instructed by the manufacturer.

4. Manufacturer’s storage instructions shall be carefully studied by the Contractor and reviewed by him with the Construction Manager. These instructions shall be carefully followed and a written record of this review kept by the Contractor.

5. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, and operate loaded when possible, weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.

6. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. Mechanical equipment to be used in the work, if stored for longer than ninety days, shall have the bearings cleaned, flushed, and

lubricated prior to testing and startup, at no extra cost to the Owner.

7. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested, and accepted in a minimum time period. As such, the manufacturer will guarantee the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective, and it shall be removed and replaced at the Contractor's expense.

8. A maintenance log shall be maintained by the Contractor outlining the schedule of maintenance required for each piece of equipment as well as the date on which the maintenance was actually performed and the initials of the individual performing the work. Submit a copy of the maintenance log monthly with the progress pay application.

1.05 WARRANTY AND GUARANTEES

A. The manufacturer's written warranty shall be submitted for all pieces of equipment, as specified in Section 01740: Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for one year after the time of completion and acceptance.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 62-555.320(3) Florida Administrative Code.

B. All copper and brass piping, fittings, valves and appurtenances shall be lead free.

2.02 MATERIALS AND QUIPMENT

A. Fabrication and

Manufacture:

1. Workmanship and Materials:

   a. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage or other failure. Materials shall be suitable for service conditions.

   b. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and gages so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

   c. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 inch thick.

2. Lubrication:

   a. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

   b. Lubricants of the type recommended by the equipment manufacturer shall be furnished by the Contractor in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by Owner. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

   c. Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

3. Safety Guards: All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on a ll sides by a safety guard. Safety guards shall be fabricated form 16 USS gage or heavier galvanized or

aluminum-clad sheet steel or 1/2 inch mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

4. Equipment Foundation Supports:

   a. All foundations, platforms and hangers required for the proper installation of equipment shall be furnished and installed by the Contractor.

   b. Unless otherwise indicated or specified, all equipment shall be installed on reinforced concrete bases at least 6 inches high and shall conform to Section 03300. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection. Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout as specified in Section 03600: Grout. All open equipment bases shall be filled with nonshrinking grout sloped to drain to the perimeter of the base.

   c. The Contractor shall furnish, install and protect all necessary guides, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installation of equipment. These shall be of ample size and strength for the purpose intended.

   d. Equipment suppliers shall furnish suitable anchor bolts for each item of equipment. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed. Anchor bolts shall comply with Section 05500: Miscellaneous Metals and, unless otherwise specified, shall have a minimum diameter of 3/4 inch. Unless otherwise indicated or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

   e. Structural steel supports and miscellaneous steel required for supporting and/or hanging equipment and piping furnished under this Division shall be provided and installed by Contractor.

f. All foundations, anchor pads, piers, thrust blocks, inertia blocks and structural steel supports shall be built to template and reinforced as required for loads imposed on them.

g. The Contractor shall assume all responsibility for sizes, locations and design of all foundations, anchor pads, pier, thrust blocks, inertia blocks, curbs and structural steel supports.

5. Shop Painting:

a. All steel and iron surfaces shall be protected by suitable paint or coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Exposed surfaces shall be finished smooth, thoroughly cleaned, and filled as necessary to provide a smooth uniform base for painting. Electric motors, speed reducers, starters, and other self- contained or enclosed components shall be shop primed or finished with a high-grade oil resistant enamel suitable for coating in the field with an alkyd enamel. Coatings shall be suitable for the environment where the equipment is installed.

b. Surfaces to be painted after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Unless otherwise specified, the shop primer for steel and iron surfaces shall be Cook "391-N-167 Barrier Coat", Koppers "No. 10 Inhibitive Primer", or equal.

c. Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound, Houghton "Rust Veto 344", Rust-Oleum "R-9", or equal.

6. Nameplates: Contractor shall provide equipment identification nameplates for each item of equipment. Nameplates shall be 1/8-inch Type 304 stainless steel and shall be permanently fastened. Plates shall be fastened using round head metallic drive screws, or where metallic drive screws are impractical, with stainless steel pop rivets. Metallic drive screws shall be brass or stainless steel, Type V and No. 8 by 3/8-inch long. Names and/or equipment designations shall be engraved on the plates and the engraving painted with a primer and black paint system compatible with stainless steel. Contractor shall submit a list of proposed names and designations for review prior to fabrication of nameplates. At a minimum, each nameplate shall include equipment manufacturers name, year of manufacture, serial number and principal rating data.

7. Pipe Identification:

   a. All pipe (except underground) shall have code letters and flow arrows painted as per specification Section 09905. The contractor shall ensure that the pipes are properly marked.

   b. Underground pipe and tube: Pipe and tube shall be located by laying 2-inch wide plastic tape continuously along the run of pipe or tube. Where possible, color of tape shall be consistent with the color of bands on interior pipe and as approved by the Engineer, or shall bear an imprinted identification of the line.

      i. Location: Tape shall be laid approximately 12 inches below ground surface and directly over pipe location.

      ii. Manufacturer: Tape shall be as specified in Section 09905.

   c. All pipe shall require insulated locating wire (10 gauge solid copper) capable of detection by cable locator and shall be wrapped with nylon straps to the centerline of the pipe.

8. Valve Identification: On all valves, except shut-off valves located at a fixture or piece of equipment, the Contractor shall provide a coded and numbered tag attached with brass chain and/or brass "S" hooks. Underground valves shall be provided with a brass plate glued onto the valve pad.

   a. Tag Types:

      i. Tags for valves on pipe and tube lines conducting hot medium (steam, condensate, hot water, etc.) shall be brass or anodized aluminum.

      ii. Tags for all other valves shall be Type 304 stainless steel.

      iii. Square tags shall be used to indicate normally closed valves and round tags shall indicate normally open valves.

   b. Coding: In addition to the color coding, each tag shall be stamped or engraved with wording or abbreviations to indicate the line service. All color and letter coding shall be approved by the Engineer.

   c. Valve Schedule: The Contractor shall provide a typewritten list of all tagged valves giving tag shape, letter code and number, the valve size, type, number of turns, and general location within building.

9. Fire Hazard Rating:

a. All piping, duct work, and equipment insulation, fastener, and jacketing materials shall have a fire hazard rating not to exceed 25 for flame spread, 50 f or fuel contributed, and 50 f or smoke developed. Rating shall be determined by ASTM Designation E84, "Surface Burning Characteristics of Building Materials". Corresponding ratings determined by Underwriters' Laboratories, Inc., UL-723, "Test Method for Fire Hazard Classification of Building Materials", will also be acceptable.

b. Flame proofing treatments will not be acceptable.

10. Heating, Ventilation and Domestic Plumbing Equipment:

a. Interchangeability: In all design and purchasing, interchangeability of items of equipment, subassemblies, parts, motors, starters, relays, and other items is essential. All similar items shall be of the same manufacturer, type, model, and dimensions.

2.03 ACCESSORIES

A. Special Tools and Accessories: Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.04 SPARE PARTS

A. Spare parts for certain equipment provided under Divisions 11, 13, 14, 15, and 16 have been specified in the pertinent sections of the specifications. The Contractor shall collect and store all spare parts in an area to be designated by the Engineer. In addition, the Contractor shall furnish to the Engineer an inventory listing of all spare part, the equipment they are associated with, and the name and address of the supplier.

B. Maintenance Materials:

1. All grease, oil, and fuel required for testing of equipment shall be furnished with the respective equipment. The Owner shall be furnished with a year's supply of required lubricants including grease and oil of the type recommended by the manufacturer with each item of equipment supplied.

2. The Contractor shall be responsible for changing the oil in all drives and intermediate drives of each mechanical equipment after initial break-in of the equipment, which in no e vent shall be any longer than three weeks of operation.

2.05 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.

PART 3 - EXECUTION

3.01 PREPARATION (Not Applicable)

3.02 INSTALLATION

A. Installation: Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary for proper results. When so specified, or when employees of Contractor or his subcontractors are not qualified, such personnel shall be field representatives of the manufacturer of the equipment or materials being installed.

1. The Contractor shall have on site sufficient proper construction equipment and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory assembled when practical.

2. Equipment shall be erected in a neat and workmanlike manner on the foundations and supports at the locations and elevations shown on the Drawings, unless otherwise directed by the Engineer during installation.

3. All equipment shall be installed in such a manner as to provide access for routine maintenance including lubrication.

4. For equipment such as pumping units, which require field alignment and connections, the Contractor shall provide the services of the equipment manufacturer's qualified mechanic, millwright, machinist, or authorized representative, to align the pump and motor prior to making piping connections or anchoring the pump base.

5. Equipment of a portable nature which require no installation shall be delivered to a location designated by the Owner.

B. Tolerances: Precision gauges and levels shall be used in setting all equipment. All piping and equipment shall be perfectly aligned, horizontally and vertically. Tolerances for piping and equipment installation shall be 1/2 inch to 30 ft horizontal and vertically. All valves and operators shall be installed in the position shown on the Contract Drawings or as directed by the Engineer, if not shown.

C. Alignment and Level: The equipment shall be brought to proper level by shims (1/4 inch maximum). After the machine has been leveled and aligned, the nuts on the anchor bolts shall be tightened to bind the machine firmly into place against the wedges or shims. Grouting shall be as specified in Section 03600: Grout.

D. Grouting: The grout shall be tamped into position with a board, steel bar, or other tool. Tamping should not be so hard as to raise or otherwise displace the plate.

E. Contact of Dissimilar Metals: Where the contact of dissimilar metal may cause electrolysis and where aluminum will contact concrete, mortar, or plaster, the contact surface of the metals shall be separated using not less than one coat of zinc chromate primer and one heavy coat of aluminum pigmented asphalt paint on each surface.

F. Cutting and Patching: All cutting and patching necessary for the work shall be performed by the Contractor.

G. Operation: All equipment installed under this Contract, including that furnished by Owner or others under separate contract, shall be placed into successful operation according to the written instructions of the manufacturer or the instructions of the manufacturer's field representative. All required adjustments, tests, operation checks, and other startup activity shall be provided.

3.03 INSPECTION AND TESTING

A. Where the specifications require observation of performance tests by the Construction Manager, such tests shall comply with the quality assurance paragraph in this section.

3.04 START-UP AND INSTRUCTION

A. Services Furnished Under This Contract:

1. An experienced, competent, and authorized representative of the manufacturer of each item of equipment shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment

installation. In each case, the manufacturer's representative shall be present when the equipment is placed in operation. The manufacturer's representative shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Construction Manager.

2. Each manufacturer's representative shall furnish to Owner, Construction Manager, a letter of certification stating that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for field services shall be included in the contract amount.

END OF SECTION

SECTION 15041

DISINFECTION OF PIPING AND STRUCTURES

PART 1 - GENERAL

1.01. DESCRIPTION

This section includes materials and procedures for disinfection of water mains by the continuous feed method and disinfection of structures. Do not use the tablet method to disinfect pipelines. Disinfect piping in accordance with AWWA C651 and disinfect structures in accordance with AWWA C652, except as modified below. Disinfection of piping and structures shall meet the requirements of the County and FDEP.

1.02. JOB CONDITIONS

A. Discharge of chlorinated water into watercourses or surface waters is regulated by the National Pollutant Discharge Elimination System (NPDES). Apply to cognizant environmental regulation authority, Florida Department of Environmental Protection and obtain permit, for permission to discharge. Disposal of the chlorinated disinfection water and the flushing water is the Contractor's responsibility.

B. Schedule the rate of flow and locations of discharges in advance to permit review and coordination with Owner and cognizant regulatory authorities.

C. Use potable water for chlorination.

D. Submit request for use of water from waterlines of Owner 48 hours in advance.

1.03. SUBMITTALS

A. Copies of all laboratory test results.

B. Copies of all FDEP correspondence.

C. Sampling location drawing.

PART 2 - MATERIALS

2.01. LIQUID CHLORINE

Inject with a solution feed chlorinator and a water booster pump. Use an experienced operator and follow the instructions of the chlorinator manufacturer.

2.02. CALCIUM HYPOCHLORITE (DRY)

Dissolve in water to a known concentration in a drum and pump into the pipeline at a metered rate.

2.03. SODIUM HYPOCHLORITE (SOLUTION)

Further dilute in water to desired concentration and pump into the pipeline at a metered rate.

2.04. CHLORINE RESIDUAL TEST KIT

For measuring chlorine concentration, supply and use a medium range, drop count, titration kit or the DPD Colorimetric method comparator with wide range color discs. Range 1.0 to 50 mg/l. Products: Hach Chemical or Hellige. Maintain kits in good working order available for immediate test of residuals at point of sampling.

PART 3 - EXECUTION

3.01. PIPELINE FLUSHING (PRE-FLUSH)

All pipelines shall be flushed clear of deleterious material prior to disinfection.

3.02. CONTINUOUS FEED METHOD FOR PIPELINES

Introduce potable water into the pipeline at a constant measured rate. Feed the chlorine solution into the same water at a measured rate. Proportion the two rates so that the chlorine concentration in the pipeline is maintained at a minimum concentration of 50 mg/l. Check the concentration at points downstream during the filling to ascertain that sufficient chlorine is being added.

3.03. DISINFECTION OF VALVES AND APPURTENANCES

During the period that the chlorine solution is in the section of pipeline, open and close valves to obtain a chlorine residual at hydrants and other pipeline appurtenances. Valves connected to the existing water system shall be manipulated by the County.

3.04. DISINFECTION OF CONNECTIONS TO EXISTING PIPELINES

Disinfect per AWWA C651, Section 9. Flush with potable water until discolored water, mud, and debris are eliminated. Swab interior of pipe and fittings with a 1% sodium hypochlorite solution. After disinfection, flush with potable water again until water is free of chlorine odor.

3.05. CONFIRMATION OF RESIDUAL

After the chlorine solution applied by the continuous feed method has been retained in the pipeline for 24 hours, confirm that a chlorine residual of 25 mg/l minimum exists along the pipeline by sampling at air valves and other points of access.

3.06. PIPELINE FLUSHING (POST-FLUSHING)

After confirming the chlorine residual, flush the excess chlorine solution from the pipeline until the chlorine concentration in the water leaving the pipe is within 0.5 mg/l of the replacement water.

3.07. BACTERIOLOGIC TESTS

The County will collect one sample per day at each sample point on two consecutive days, and deliver to the County laboratory, and obtain a bacteriologic quality test to demonstrate the absence of coliform organisms in each separate section of the pipeline and in each structure after chlorination and refilling. For lines longer than 2 miles, obtain one additional test each mile. At each connection to an existing pipeline, take two additional samples.

3.08. REPETITION OF PROCEDURE

If the initial chlorination fails to produce required residuals and bacteriologic tests, repeat the chlorination and retesting until satisfactory results are obtained.

3.09. TEST FACILITY REMOVAL

After satisfactory disinfection, replace air valves, restore the pipe coating, and complete the pipeline where temporary disinfection or test facilities were installed. Any test station removed prior to receipt of acceptable lab results will be required to be replaced at the Contractor's expense should retesting be required.

3.10. PIPING TO BE DISINFECTED

1. Disinfect all piping as indicated on the Piping Schedule in the drawings.

2. Disinfect (internally and externally) any piping inside the following structures:

    a. N/A.

3.11. DISINFECTION OF STRUCTURES

1. Disinfect per AWWA C652, Method 2.

2. Disinfect the interior of the following structures:

   a. N/A.

3. Remove any chlorine solution which accumulates in the bottom of the structure each day.

4. The Owner will provide potable water at no cost to the Contractor for the first disinfection effort. If bacteriological testing shows that the first disinfection effort was not successful, the Contractor will be charged the cost of additional water at the Owner's current rates.

END OF SECTION

SECTION 15044

PRESSURE TESTING OF PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: This section specifies the leakage testing requirements for plant piping.

B. Related Work Described Elsewhere:

1. Section 15062: Ductile Iron Pipe and Fittings.
2. Section 15070: Schedule 80 Polyvinyl Chloride (PVC) Pipe, Fittings and Valves.
3. Section 15090: Chemical Feed System Piping.

C. General Design (not applicable)

1.02 QUALITY ASSURANCE

A. Test Pressures: Test pressures for the various services and types of piping shall be as shown in Table 15044-A and at a minimum shall be 1.5 times the working pressure.

1.03 SUBMITTALS

A. Materials and Shop Drawings (Not Applicable)

B. Additional Information:

1. Testing Plan: Submit prior to testing and include at least the information that follows:

a. Testing dates.

b. Piping systems and section(s) to be tested.

c. Test type.

d. Method of isolation.

e. Calculation of maximum allowable leakage for piping section(s) to be tested.

2. Certifications of Calibration: Testing equipment.

3. Certified Test Report.

4. Testing Records:

a. Provide a record of each piping installation during the testing. These records shall include:

i. Date of test.

ii. Identification of pipeline tested or retested.

iii. Identification of pipeline material.

iv. Identification of pipe specification.

v. Test fluid.

vi. Test pressure.

vii. Remarks: Leaks identified (type and location), types of repairs, or corrections made.

viii. Certification by Contractor that the leakage rate measured conformed to the specifications.

ix. Signature of Owner's representative witnessing pipe test.

b. Submit five (5) copies of the test records to the Engineer's representative upon completion of the testing.

PART 2 - PRODUCTS

2.01 GENERAL

A. Testing fluid shall be clean water for all piping except air service and shall be of such quality to prevent corrosion of materials in piping system for all hydrostatic tests. Air piping shall be tested using compressed air.

2.02 MATERIALS AND EQUIPMENT

A. Provide pressure gauges, necessary bracing and restraint, test plugs, pipes, bulkheads, pumps, and meters to perform the hydrostatic and pneumatic testing.

PART 3 - EXECUTION

3.01 PREPARATION

A. Pipes shall be in place and anchored before commencing pressure testing.

B. Conduct hydrostatic and pneumatic tests on exposed and aboveground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.

C. Before conducting hydrostatic tests, flush pipes with water to remove dirt and debris. For pneumatic tests, blow air through the pipes.

D. Test new pipelines which are to be connected to existing pipelines by isolating the new line from the existing line by means of pipe caps, special flanges, or blind flanges. After the new line has been successfully tested, remove caps or flanges and connect to the existing piping.

E. Conduct hydrostatic tests on buried pipe after the trench has been completely backfilled. The pipe may be partially backfilled and the joints left exposed for inspection for an initial leakage test. Perform the final test, however, after completely backfilling and compacting the trench.

F. Chlorine Piping: Test, dry, and clean in accordance with requirements of Chlorine Institute Pamphlet 6.

G. New Piping Connected to Existing Piping: Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to ENGINEER.

H. Items that do not require testing include: Piping between wet wells and wet well isolation valves, equipment seal drains, tank overflows to atmospheric vented drains, and tank atmospheric vents.

I. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.

2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to ENGINEER.

J. Pressure Test:

1. All tests shall be made in the presence of and to the satisfaction of the Owner or Engineer and also, to the satisfaction of any local or state inspector having jurisdiction.

a. Provide not less than three (3) days notice to the Owner, Engineer, and the authority having jurisdiction when it is proposed to make the tests.

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

c. The piping systems may be tested in sections as the work progresses, but no joint or portion of the system shall be left untested.

2. All elements within the system that may be damaged by the testing operation shall be removed or otherwise protected during the operation.

3. Repair all damage done to existing or adjacent work or materials due to or on account of the tests.

3.02 INSTALLATION (Not Applicable)

3.03 INSPECTION AND TESTING

A. Hydrostatic Testing of Aboveground or Exposed Piping: The maximum filling velocity shall be 0.25 feet per second, applied over full area of pipe. Open vents at high points of the piping system to purge air while the pipe is being filled. Subject the piping system to the test pressure indicated. Maintain the test pressure for a minimum of four (4) hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show no leakage or weeping. Correct leaks and retest until no leakage is obtained.

B. Hydrostatic Testing of Buried Piping:

1. Test after backfilling has been completed. Expel air from piping system during filling.

2. Where any section of the piping contains concrete thrust blocks or encasement, do not make the pressure test until at least 10 days after the concrete has been poured. When testing mortar-lined piping, fill the pipe to be tested with water and allow it to soak for at least 48 hours to absorb water before conducting the pressure test.

3. Apply and maintain the test pressure by means of a hydraulic force pump. Maintain the test pressure for a minimum duration of four (4) hours. After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure during the four hours. This amount of water is the loss due to leakage in the piping system. The allowable leakage rate is defined by the formula.

$$L = \frac{SD(P)^{1/2}}{148{,}000}$$

in which:

L	=	allowable leakage (gallons/hour) during the test period.
S	=	length of pipe, in feet
D	=	nominal diameter of the pipe (inches)
P	=	average test pressure during leakage test (psig)

3. Repair and retest any pipes showing leakage rates greater than that allowed.

C. Pneumatic Test For Pressure Piping:

1. Do not perform on PVC or CPVC pipe.

2. Fluid: Oil-free, dry air.

3. Procedure:

a. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections, examine for leakage.

b. Correct visible leaks and repeat preliminary test until visible leaks are corrected.

c. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately

one-tenth of specified test pressure until required test pressure is reached.

d. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.

e. Correct visible leakage and retest as specified.

4. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

5. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

D. Hydrostatic Test For Gravity Piping:

1. Testing Equipment Accuracy: Plus or minus 1/2 gallon of water leakage under specified conditions.

2. Maximum Allowable Leakage: 0.16 gallon per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

3. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.

4. Exfiltration Test:

a. Hydrostatic Head:

i. At least 6 feet above maximum estimated groundwater level in section being tested.

ii. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.

5. Infiltration Test:

a. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

6. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

7. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

E. Test Pressure:

1. All pipe shall be tested at pressures shown in Table 15044-A and at a minimum shall be 1.5 times the normal working pressure of the pipe.

3.04 START-UP AND INSTRUCTION (Not Applicable)

TABLE 15044-A

Service	Legend	Maximum Operation Pressure (psig)	Test Pressure (psig)
Drain	DR	Gravity	15 ft. WCH
Fuel	FS, FR	20	50
Hydrofluosilicic Acid	HFA	50	100
Plant Service Water	SVW	70	150
Potable Water	PW	70	150
Raw Water	RW	25	100
Sample Line	SA	70	150
Sodium Hypochlorite	NaOCL	50	100
Water Main	WM	70	150
Force Main	FM	70	150

Legend: WCH = Water Column Height

END OF SECTION

SECTION 15058

COMMON MOTOR REQUIREMENTS FOR HVAC AND PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

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

1.03 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.

3. Ratings and characteristics of supply circuit and required control sequence.

4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

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

2.02 MOTOR CHARACTERISTICS

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

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

2.03 POLYPHASE MOTORS

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

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

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.

2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

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

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.

2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

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

2.04 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

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

B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.

2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.

3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

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

2.05 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.

2. Split phase.

3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

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

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

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

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

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 15061

STEEL PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment, and incidentals required and install, complete, ready for operation and field test all steel pipe as shown on the Drawings and specified herein.

2. Steel pipe shall include black steel and galvanized steel pipe and fittings.

3. Provide steel pipe only where specifically called out on the Drawings.

B. Related Work Described Elsewhere:

1. Pressure Testing of Piping: Section 15044.

2. Cathodic Protection System: Section 15060.

3. Chemical Feed System Piping: Section 15090.

4. Valves and Appurtenances: Section 15100.

5. Pipe hangers and supports: Section 15126.

6. Couplings and Connectors: Section 15129.

C. General Design (Not Applicable)

1.02 QUALITY ASSURANCE

A. All steel pipe shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the steel pipe to be furnished. The equipment shall be designed, constructed, installed in accordance with the best practices and methods and shall comply with all these specifications.

B. Steel pipe and fittings shall conform to all applicable standards of ASTM, ANSI, and AISI.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Submit to the Engineer for approval in accordance with the General Conditions and Section 01340, shop drawings to include dimensions and technical specifications for all piping to be furnished.

2. Piping layout drawings showing location and dimensions of all pipe and fittings.

3. Include lay lengths of valves, meters, and other equipment which determine piping dimensions. Label or number each fitting or piece of pipe and provide the following information for each item:

a. Materials of construction, including references to industry standards being met (i.e. ASTM, ANSI, AWWA, etc.).

b. Inside diameter, steel wall thickness, internal design pressure (cement-mortar lining and coating thicknesses) for each class of pipe to be furnished.

c. Order of installation and closure locations for length adjustment and for construction convenience.

d. Pipe invert station and elevation of each change of grade and alignment.

e. Elements of curves and bends, both in horizontal and vertical alignment, including elements of the resultant true angular deflections in cases of combined curvature.

f. Paint primer type and thickness where joints and other cement-mortar holdbacks occur.

g. Call out types and sizes, and dimensions of grooved-end collars, flanges, reinforcing collars, wrapper plates, and crotch plates.

h. Limits of each reach of field-welded joints and of concrete encasement.

i. Location of valves and other mechanical equipment.

j. Locations of bulkheads for field hydrostatic testing of pipeline.

3. Manufacturer's certificates of compliance with prescribed industry standards (i.e. AWWA C-200, C-205, C-206, C-207 and C-208, ASTM C-150, etc.)

4. Detail drawings of:

   a. Fittings

   b. Joints

   c. Butt Straps

   d. Bulkheads and means of attachment to pipe.

5. Mill test reports on each heat from which steel is rolled.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The equipment provided under this section shall be shipped, handled and stored in accordance with the manufacturer's written instructions, and in accordance with Section 01600 - Material and Equipment.

1.05 WARRANTY AND GUARANTEES

A. Provide equipment warranty in accordance with Section 01740 - Warranties and Bonds.

PART 2 - MATERIALS

2.01 GENERAL

A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 62-555 Florida Administrative Code.

2.02 STEEL PIPE AND FITTINGS (4-INCH DIAMETER AND GREATER):

A. Pipe shall conform to AWWA C-200, AWWA M-11, latest edition. Steel shall be ASTM A-36, ASTM A-1011 or A-1018, Grade 36, having a 0.25% maximum carbon content.

1. Steel cylinder thickness shall be minimum of 1/4-inch (0.2500 inches) for straight runs of distribution and transmission pipe with diameters less than 30-inches and shall be a minimum of 3/8-inch (0.3750 inches) for diameters 30-inches and larger.

B. Cement

1. Cement for cement-mortar lining shall be ASTM C-150, Type II or V. Cement for cement-mortar coating shall be ASTM C-150, Type V.

C. Fittings

1. Definition: A fitting shall be defined as a piece of pipe other than a straight full length joint. Elbows, manhole sections, reducers, and sections of pipe with outlets shall be considered fittings. Dimensions shall be per AWWA C-208.

2. Pressure Rating: Fittings 4 through 10-inches diameter shall be designed for 250 psi and conform to ANSI B16.9. Fittings 12-inches diameter and larger shall comply with AWWA C-208. Note, the minimum plate thickness required for Section A herein, above.

3. Materials: Material for fittings 4 through 10-inches shall comply with ASTM A-234, Grade WPB. Material for fittings larger than 10-inches but less than or equal to 30-inches in diameter shall be the same as the pipe. Cement-mortar lining and I.D. dimensions shall be the same as the specified pipe.

4. Allowable Stresses: Allowable circumferential stress at the design internal pressure shall not be greater than 40% of minimum yield stress. Minimum wall thickness of steel fitting shall be the same as the pipe of same size per ANSI B36.10 and as required in Section A, herein, above.

5. Welding Fittings: Welding fittings shall be standard weight, Tube Turns, or Engineer approved equal.

6. Flanges:

    1. Flanges shall be AWWA C-207, Class D, flat face, except where Class E or Class F flanges are required.

7. Bolts, Nuts, and Gaskets for Joints and Flanges:

a. Rubber gaskets shall be furnished for all joints, along with other parts, including flange gaskets, bolts, nuts, washers, jumper rods, and flange insulation kits. One bolt/gasket set shall be provided for each flange.

b. Materials: Bolts and nuts for flanges shall be Type 316 stainless steel conforming to ASTM A-193, Grade B8M for bolts, and ASTM A-194, Grade 8M for nuts.

c. Washers: A washer shall be provided for each nut. Washers shall be of the same material as the nuts.

d. Gaskets: Gaskets shall be composed of synthetic fiber with rubber binder and shall be "full-faced", 1/16-inch-thick Garlock 3400, Anchor 441, or Engineer approved equal, conforming dimensionally to ANSI B16.21. Ring gaskets extending to the inner edge of flange bolts may be used where a raised face flange is present.

e. Bolts for Flange Insulation Kits: Bolts and nuts for flange insulation kits shall conform to the same requirements as outlined in paragraph 2 above.

8. Flange Insulation Kits:

a. Flange insulation kits suitable for the design pressure of the pipeline shall be provided where shown on the drawings and shall be as specified in Division 16.

9. Joints:

a. Above Ground Joints: Joints above ground or in vaults and structures shall be flanged or grooved end, unless specifically indicated otherwise on the project plans.

b. Buried Joints: Buried joints shall be:

i. Beveled ends for butt welding.

ii. Butt-strap joints. Closure pieces may also require Butt-strap joints with "hand-holes" and threaded-steel plugs welded into place (for proper repair of the lining of the interior pipe joints).

2.03. STEEL PIPE AND FITTINGS (LESS THAN 4-INCH DIAMTER):

A. Steel piping shall be Schedule 80 black steel as shown on the Drawings or required in the Specifications.

B. Steel Pipe shall meet the following standards:

1.	Pipes:	ASTM A-53, extra strong Type S.
2.	Nipples:	ASTM A-733, seamless, extra strong Schedule 80; "close" nipples will be permitted only by special authorization in each case.
3.	Forced Steel Fittings:	ANSI B16.11; Bonney, Crane, Ladish, Vogt, or equal.
a.	Socket Welding	Class 3000.
b.	Threaded	Class 2000 or Class 3000.

2.04 ACCESSORIES

A. Steel Pipe Sleeves:

1. Sleeves for pipes passing through floors and walls shall be galvanized Schedule 40 steel pipe conforming to ASTM Designation A120. Sleeves dimensions shall conform to the details shown on the Drawings. Sleeve ends shall be cut and ground smooth. Sleeves shall be flush with walls and ceiling but shall extend above the floor as shown on the Drawings. Sleeves for use with mechanical type seals shall be sized in conformance with the seal manufacturers requirements. Mechanical type seals are specified in Section 15100.

B. Pipe supports, anchors, blocking and hangers shall be fabricated in accordance with the details shown on the drawings and shall be installed complete with all accessories required for proper operation of the system. Should it be necessary to modify the details for proper installation, all such modifications shall be subject to approval by the Engineer. Lugs required for anchorage of the piping system shall be attached in the shop and coated as the adjacent pipe.

C. Coating and Lining:

1. General: Unless noted otherwise, pipe and fittings shall be cement-mortar lined per AWWA C-205.

2. Exposed Pipe: Pipe located above ground or in vaults and structures shall be painted in accordance with Section 09900: Painting. Primer shall be shop applied.

3. Buried Pipe: Buried piping shall be tape wrapped in accordance with AWWA C214.

2.05 SPARE PARTS (Not Applicable)

2.06 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.

PART 3 - EXECUTION

3.01 FABRICATION

A. Reference Standards: Fabrication shall comply with ANSI B31.3, Chapter V. Welding procedure and performance qualifications shall be in accordance with Section IX, Articles II and III, respectively, of the ASME Boiler and Pressure Vessel Code.

3.02 INSTALLATION

A. Steel pipe shall be installed true to alignment, and rigidly supported anchors shall be provided where indicated.

B. Sleeves of the proper size shall be installed for pipes passing through floors and walls as indicated on the Drawings. Sleeves shall be given a prime coat of rust inhibitive primer as specified in Section 09900.

C. Threaded Joints:

1. Ream the ends of threaded pipe to remove all burrs.

2. Cut threads clean with long tapers.

3. Remove all dirt and chips from the inside of the pipe and fittings and from the threads.

4. Make up joints with an approved pipe joints compound or tape applied to the male threads only.

5. When connecting pipes to recessed drainage fittings, seat them against the shoulder of the fittings.

6. When required to back off joints, entirely disjoint, wipe the threads of both the pipe and fittings clean, apply new joint compound, and reassemble the connection.

D. Welded Connections:

1. The pipe cylinder shall be fabricated by butt welding, spiral seam, or straight seam. Girth welds shall be limited to two per pipe section, butt welded. Longitudinal welds shall be limited to one seam. Longitudinal joints of adjacent shell courses shall be staggered.

2. For field welding, the shielded metal arc welding (SMAW) process shall be used. For the shop fabrication of special fittings and appurtenances, the submerged arc welding (SAW) process and the flux cored arc welding (FCAW) process are acceptable alternates. All welding shall be done by qualified, certified welders.

3. Welds shall be in accordance with ANSI B31.3, paragraph 327.4.

4. Welding preparation shall comply with ANSI B31.3, paragraph 327.3.

5. Limitations on imperfections in welds shall conform to the requirements in ANSI B31.3.

6. For the SMAW process, welding electrodes shall comply with AWS A5.1. For the SAW process welding electrodes shall comply with AWS A5.17. For the FCAW process welding electrodes shall comply with AWS A5.20.

7. Each layer of deposited weld metal shall be cleaned using a power-driven wire brush prior to depositing the next layer of weld metal. The final pass shall be cleaned by a power-driven wire brush.

8. For field welds using the SMAW process, a minimum of three passes shall be used for welded joints on pipes 36-inches in diameter and larger. Welds shall be full circumferential.

9. For controlled shop welding processes using SAW or FCAW, weld joints may be made with two passes.

10. Beveled ends for butt welding shall conform to ANSI B16.25. Slag shall be removed by chipping or grinding. Surfaces shall be clean of

paint, oil, rust, scale, slag, and other material detrimental to welding. When welding the reverse side, slag shall be chipped out before welding.

E. Flanged Joints:

1. Tighten flange bolts so that the gaskets are uniformly compressed and sealed.

2. Do not distort flanges.

3. Leave flange bolts with the ends projecting 1/8-inch to 3/8-inch beyond the faces of the nuts after tightening.

4. Gasket material shall be compatible with pipeline fluid.

G. Cutting:

1. Cut pipe from measurement taken at the site; not from the Drawings.

2. When cutting of pipe is required, the cutting shall be done by machine in a neat workmanlike manner without damage to the pipe. Cut ends shall be smooth and at right angles to the axis of the pipe.

H. To permit convenient disassembly for alterations and repairs, install unions or flanges where shown on the Drawings and:

1. In long runs of piping;

2. In bypasses around equipment;

3. In connections to traps, tanks, pumps, and other equipment;

4. Between shutoff valves; and

5. In other locations as directed by the Engineer, and as indicated on the Drawings.

I. Painting:

1. Pipe and fittings exposed to view, except stainless steel, shall receive a prime coating of rust inhibitive primer specified in Section 09900. Prior to prime coating, all surfaces shall be cleaned of all mill scale, rust, dirt, grease and other foreign matter.

3. All piping and fittings exposed to view except stainless steel pipe shall be painted as specified in Section 09900. Pipe marking is included in Section 09905.

3.03. SHOP TESTING OF FITTINGS

A. Dye Penetrant Test: Seams in fittings which have not been previously shop hydrostatically tested shall be tested by the dye penetrant method as described in ASME Boiler and Pressure Vessel Code Section VIII, Appendix B.

B. Air-Soap Test: In addition to the dye penetrant method of testing, the air-soap method with air at 5 psi shall be used on joints susceptible to being tested by such a method.

C. Pressure Test in Lieu of Dye Penetrant Test: In lieu of the dye penetrant method of testing, completed fittings may be hydrostatically tested using the field hydrostatic test pressure or 125% of the design pressure, whichever is higher.

3.04 INSPECTION AND TESTING (See Section 15044 - Pressure Testing of Piping)

3.05 DISINFECTION (See Section 15041 – Disinfection of Piping and Structures)

3.06 START-UP AND INSTRUCTION (Not Applicable)

END OF SECTION

SECTION 15062

DUCTILE IRON PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: Furnish all labor, materials, equipment and incidentals required and install, in the locations inside, and under buildings and structures as shown on the Drawings, all ductile iron piping, cast or ductile iron fittings, and appurtenances as specified herein.

B. Related Work Specified Elsewhere:

1. Pressure Testing of Piping: Section 15044.
2. Cathodic Protection System: Section 15060.
3. Valves and Appurtenances: Section 15100.
4. Pipe hangers and supports: Section 15126.
5. Couplings and Connectors: Section 15129.

C. General Design: The equipment and materials specified herein is intended to be standard types of ductile iron pipe and cast or ductile iron fittings for use in transporting sewage, sludges, and water. All materials that contact drinking water or drinking water chemicals shall comply with AWWA Standards and NSF Standard 61.

1.02 QUALITY ASSURANCE

A. Qualifications: All of the ductile iron pipe and cast or ductile iron fittings shall be furnished by manufacturers who are fully experienced, reputable, and qualified in the manufacture of the materials to be furnished. The pipe and fittings shall be designed, constructed, installed in accordance with the best practices and methods and shall comply with these specifications as applicable.

B. Standards

1.	Ductile Iron Pipe Thickness: ANSI A 21.50/AWWA C150	5.	Ductile Iron Compact Fittings for Water Service: ANSI A-21.53/AWWA C153
2.	Ductile Iron Pipe Centrifugally Cast: ANSI A-21.51/AWWA C151	6.	Polyethylene Encasement for Ductile Iron Pipe: ANSI A-21.5/AWWA C105
3.	Cement Mortar Lining for Water: ANSI A-21.4/AWWA C104	7.	Installation of Ductile Iron Water Mains: AWWA C600
4.	Cast and Ductile Iron Fittings: ANSI A-21.10/AWWA C110	8.	Disinfection of Water Mains: AWWA C651

C. Factory Tests: The manufacturer shall perform the factory tests described in ANSI A-21.51/AWWA C151.

D. Quality Control

1. The manufacturer shall establish the necessary quality control and inspection practice to ensure compliance with the referenced standards.

2. In addition to the manufacturer's quality control procedures, the Owner may select an independent testing laboratory to inspect the material at the foundry for compliance with these specifications. The cost of foundry inspection requested by the Owner will be paid for by the Owner.

E. Manufacturers: Manufacturers shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications.

1.03 SUBMITTALS

A. Materials and Shop Drawings

1. Submit shop drawings, including pipeline layouts, within and under buildings and structures. Shop drawings shall include dimensioning, methods and locations of supports and all other pertinent technical specifications. Shop drawings shall be prepared by the pipe manufacturer. Shop drawings for piping within and under buildings and structures shall be submitted within 30 days of Execution of Contract.

2. For all pipes in contact with potable or raw water, submit certification that pipe and fittings meet the requirements of NSF 61.

B. Operating Instructions: Submit Operation and Maintenance Manuals in accordance with Section 01730. Pipe dimensions and liner thickness shall be provided in the Operation and Maintenance Manuals.

C. Manufacturer's Certification: Submit certification of compliance with the following, sworn by a corporate officer of the manufacturer and witnessed by a notary:

1. Factory tests and results

2. Dimensions and weights of fittings per respective AWWA Standard.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and Storage: Delivery and storage of the materials shall be in accordance with the manufacturer's recommendations.

B. Handling: Care shall be taken in loading, transporting and unloading to prevent damage to the pipe or fittings and their respective coatings. Pipe or fittings shall not be rolled off the carrier or dropped. Unloading shall be done by lifting with a forklift or crane. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Ductile Iron Pipe

1. Standards: ANSI A-21.50, AWWA C150 and ANSI A-21.51, AWWA C151

2. Thickness

a. Below ground piping: Pipes shall be the following minimum thickness class unless otherwise noted or specified.

1) 4 through 12-inch diameter	Class 350
2) 14 through 24-inch diameter	Class 250
3) 30 through 64-inch diameter	Class 200

b. Above Ground Piping
1) Flanged, Class 53 (Minimum)

3. Joints

a. Push-on or Mechanical Joints (below ground piping):

1) Standards: ANSI A21.11/AWWA C111
2) Class: The working pressure of the joint shall be equal to or exceed the rated working pressure of the pipe.
3) Gaskets: SBR (Styrene Butadine Rubber)

b. Flanged (above ground or inside below ground vaults):

1) Standards: ANSI A21.15, ANSI B16.1

2) Class: 125 lb factory applied screwed long hub flanges, plain faced without projection.

3) Gaskets

(a) Spans less than 10 feet: full face 1/8-inch thick neoprene rubber

(b) Spans greater than 10 feet: Toroseal gaskets as manufactured by American Cast Iron Pipe or equal.

c. Restrained Joints

1) Restrained joints shall be selected from one of the specified "Manufacturers" and types specified in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications, or approved equal.

2) Class: 250 psi (minimum) design pressure rating

3) Standard mechanical joint retainer glands will not be acceptable.

d. Joint Accessories

1) Mechanical joint bolts, washers and nuts: Ductile iron or Corten steel.

2) Flanged joint bolts, washers and nuts:

(a) Above Ground: Hot dipped galvanized, Grade B, ASTM A-307

(b) Below Ground: 304 stainless steel

e. Pipe Length (below ground installation): 20 feet maximum nominal length.

B. Fittings

1. Materials: Ductile iron or grey cast iron, AWWA C 110

2. Pressure Class

a. Mechanical Joint, Restrained Joint

1) 4-inch through 48-inch minimum 250 psi pressure rating

2) 54-inch through 64-inch minimum 150 psi pressure rating

b. Flanged Joint: Class 125, plain

3. Compact Fittings:

   a. Mechanical Joint, restrained joint 4-inch through 64-inch: ANSI/AWWA A21.53/C153

   b. Flanged Joint 4-inch through 48-inch: ANSI/AWWA C110/A21.10

   c. Flanged Joints 54-inch through 64-inch: ANSI/AWWA A21.53/C153

4. Manufacturers: Manufacturers shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications, or approved equal.

C. Wall Penetrations

1. Wall Pipes

   a. Material: Ductile iron or cast iron

   b. Type: Welded-on wall collar/water stop located in the center of the wall.

   c. Design: Full thrust at 250 psi transmitted to the structure wall. Tapped mechanical joint wall pipes may be used to facilitate concrete form work.

2. Wall Sleeves

   a. Material: Galvanized Schedule 40 Steel Pipe, ASTM A120

   b. Design: as manufactured by Thunderline Corporation, "Link Seal" or equal.

2.02 COATINGS, MARKINGS AND LININGS

A. Exterior Coatings

1. Below ground or in a casing pipe

   a. Type: Asphaltic coating, 1.0 mil DFT

   b. Markings: (continuous 2-inch wide stripe within top 90 degrees of pipe - min. drying time 30 minutes before backfill). All ductile iron pipe shall be marked with a continuous stripe located within the top 90 degrees of the pipe. Said stripe shall be a minimum 2 inches in width and shall be oil based paint, blue in color for potable water, green for wastewater and purple for reuse. Backfill shall not be placed for 30 minutes following paint application. At the

Contractor's option, the pipe may be stripe marked prior to pipe installation as follows:

Up to 8-inch diameter:	(2) 2-inch wide @ 180°
10 to 16-inch diameter:	(3) 2-inch wide @ 120°
18 to 24-inch diameter:	(4) 2-inch wide @ 90°
30 to 54-inch diameter:	(6) 2-inch wide @ 60°

Alternately, all ductile iron pipe may be marked along the crown of the pipe with an adhesive Underground Utility marking tape. Said tape shall be a minimum 6 inches width with a minimum 4.0 mil overall thickness inert plastic film formulated for extended use underground. Tape shall be specified and supplied in accordance with the A.P.W.A. national color code and shall be imprinted with the appropriate legend to define the type of utility line it protects.

c. Color: Potable Water: blue
Wastewater: green

2. Above Ground

a. Not subject to non-potable water submergence or splashing: See Division 9.

b. Subject to non-potable water submergence or splashing: See Division 9.

c. Color: See Division 9.

B. Interior Lining (Applied by pipe manufacturer)

1. Potable Water: Cement-mortar lining for ductile iron pipe and ductile and gray iron fittings for water service is in accordance with ANSI/AWWA C104/A21.4, and is listed by ANSI/NSF Standard 61 for potable water contact.

C. Polyethylene Encasement (required for all below ground piping, fittings and appurtenances located less than 10 feet from a gas main and as indicated on the Drawings):

1. Standard: ANSI A 21.5/AWWA C105, 8 mil minimum thickness.

2. Color: Color coded per paragraph A.1. above.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Standards: AWWA C600-05

B. Underground Ductile Iron Pipe and Fittings

1. Bedding for Ductile Iron Pipe: Minimum bedding requirements shall be Type 4 as defined in ANSI/AWWA C600, latest revision. Provide proper bedding required, in accordance with thickness class of pipe being laid and depth of cover. Property pipe laying conditions shall be in accordance with ANSI/AWWA C150 and C151, latest revisions, and ANSI/AWWA C600, latest revision.

2. Placement

a. Alignment: In accordance with lines and grades shown on the Drawings. Deflection of joints shall not exceed 75 percent of that recommended by the manufacturer.

b. Polyethylene encasement: Provide polyethylene wrap around piping, fittings and appurtenances located less than 10 feet from a gas main and as indicated on the Drawings.

3. Cutting: When required, cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of the pipe to be used with a push-on bell shall be beveled. All cut ends shall be coated with manufacturer's coating system.

4. Joints

a. Joint Placement

1) Push on joints: Pipe shall be laid with the bell ends facing upstream. The gasket shall be inserted and the joint surfaces cleaned and lubricated prior to placement of the pipe. After joining the pipe, a metal feeler shall be used to verify that the gasket is correctly located.

2) Mechanical Joints: Pipe and fittings shall be installed in accordance with the "Notes on Method of Installation" under ANSI A21.11/AWWA C111. The gasket shall be inserted and the joint surfaces cleaned and lubricated with soapy water before tightening the bolts to the specified torque.

3) All piping joints shall be mechanically restrained. Bells shall be painted red.

C. Above ground and interior ductile iron pipe and fittings

1. Pipe Supports

a. General: All piping shall be properly supported with hangers, supports, base elbows and tees, concrete piers and pads as shown on the Drawings and specified in Section 15126: Hangers and Supports and herein. All pipe and appurtenances connected to equipment shall be supported to prevent any strain from being imposed on the equipment.

b. Support spacing: 8 feet on centers and at each fitting and where shown on the Drawings.

c. Hangers for Horizontal Piping

1) Material: Heavy malleable iron

2) Type: Adjustable, swivel, split ring or adjustable swivel, pipe-roll

d. Hangers for vertical piping

1) Material: Wrought Iron

2) Type: Clamp

2. Placement

a. Alignment: In accordance with lines and grades shown on the Drawings. Each section of pipe shall be cleaned thoroughly prior to installation.

3. Flanged Joints: Joints shall be fitted so that the contact faces bear uniformly on the gasket.

D. Thrust Restraint

1. General: Thrust restraint shall be accomplished by restrained joints.

2. Length of Restrained Joints: Restrained joints shall be provided for all buried piping systems as indicated on the Drawings to restrain system thrust. It is intended that all buried joints be restrained.

E. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or by other means approved by Utilities to ensure absolute cleanliness inside the pipe.

3.02 CLEANING

A. General: At the conclusion of the work, the Contractor shall thoroughly clean the new pipe lines by flushing with water or other means to remove all dirt, stones or other material which may have entered the line during the construction period.

B. Correction of Non-Conforming Work: All non-conforming work shall be repaired or replaced by the Contractor at no additional expense to the Owner. Non-conforming work shall be defined as failure to adhere to any specific or implied directive of this Project Manual and/or the drawings, including but not limited to pipe not laid straight, true to the lines and grades as shown on the drawings, damaged or unacceptable materials, misalignment or diameter ring deflection in pipe due to bedding or backfilling, visible or detectable leakage and failure to pass any specified test or inspection.

3.03 INSPECTION AND TESTING

A. All pipe shall be inspected and tested at the Foundry.

B. The Owner shall have the right to have any or all piping, fittings or special castings inspected and tested by an independent testing agency at the foundry or elsewhere. Such inspections and testing will be at the Owner's expense.

C. Mark as rejected and immediately remove from the job site, all pipe lengths showing a crack, damaged lining or receiving a severe blow that may cause an incipient fracture, even though no such fracture can be seen.

D. Removal of Cracked Portions

1. Any pipe showing a distinct crack, but no incipient fracture beyond the limits of the visible crack, may be cut off and the sound portion installed. Cut the pipe at least 12-inches from the visible limits of the crack. Cutting of pipe shall be done by skilled workmen, and in such a manner as to not damage the pipe. Every cut shall be square and smooth, with no damage to the pipe lining. Cut surfaces shall be recoated as specified for the pipe.

2. Cutting and installing cracked pipe shall only be performed when approved by the Engineer, and shall be at the expense of the Contractor.

E. Carefully inspect and hammer test all pipe and fittings prior to installation.

F. Hydrostatic Testing: Test in accordance with Section 15044: Pressure Testing of Pipe. Test pressures are shown in the Piping Pressure Test Schedule, Table 15044-A of Section 15044.

3.04 DISINFECTION (See Section 15041 – Disinfection of Piping and Structures)

END OF SECTION

SECTION 15093

SLEEVES AND SLEEVE SEALS FOR HVAC AND PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Sleeves.

2. Sleeve-seal systems.

3. Grout.

4. Silicone sealants.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 SLEEVES

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

1. Advance Products & Systems, Inc.

2. CALPICO, Inc.

3. GPT; an EnPro Industries company.

B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, anti-corrosion coated with plain ends and integral welded waterstop collar.

2.02 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.

2. CALPICO, Inc.

3. Metraflex Company (The).

B. Description:

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

2. Designed to form a hydrostatic seal of 20-psig.

3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.

4. Pressure Plates: Composite plastic.

5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

2.04 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, use NT.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

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

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

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

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

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

D. Install sleeves for pipes passing through interior partitions.

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

2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.03 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls Above Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves and Sleeve-seal systems.

2. Concrete Slabs-on-Grade:

    a. Piping Smaller Than NPS 6: Steel pipe sleeves and Sleeve-seal systems.

3. Interior Partitions:

    a. Piping Smaller Than NPS 6: Steel pipe sleeves.

END OF SECTION

SECTION 15098

ESCUTCHEONS FOR HVAC AND PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Escutcheons.

2. Floor plates.

1.03 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

A. ESCUTCHEONS

B. One-Piece, Cast-Brass Type: With polished brass finish and setscrew fastener.

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

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

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

PART 3 - EXECUTION

3.01 INSTALLATION

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

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

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.

b. Chrome-Plated Piping: One-piece cast brass or split-plate steel with polished, chrome-plated finish. Retain one of four "Bare Piping at Wall and Floor Penetrations in Finished Spaces" subparagraphs below.

c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.

d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.

e. Bare Piping in Unfinished Service Spaces: One-piece cast brass with rough-brass finish.

f. Bare Piping in Equipment Rooms: One-piece cast brass with rough-brass finish.

3.02 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 15100

VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Scope of Work: Furnish, install, support, and test valves, gates, hydrants, strainers, stops, and faucets, (hereinafter referred to as "valves") in the location(s) and of the size(s) and quantities shown on the Drawings. The requirements of this specification apply to all valves specified.

B. General Design

1. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of sewage, water, sludge, chemicals, air, etc., depending on the applications.

2. All valves and appurtenances shall have the name of the manufacturer and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

3. For all buried valves in which the operating nut is deeper than four (4) feet from the finish ground surface, an extension rod with 2 inch operating nut and upper guide shall be installed permanently in the riser section.

4. All exposed valves shall have "open/closed" position indicators. The position indicators shall be conveniently located for easy visibility. Valves shall open counter clockwise.

5. All valves installed such that actuators are more than six feet above the floor shall have chain wheel operated geared actuators with stainless steel chains. Gear actuators shall be bevel or spur gear as recommended by the manufacturer.

6. All exposed valves 6 inches and larger shall be handwheel operated.

7. Valve packing shall be replaceable without removing the valve from service.

8. All valves in water service shall be in accordance with ANSI/NSF61.

1.02 QUALITY ASSURANCE

A. Qualifications

1. All equipment furnished under this Specification shall be new and unused and shall be a standard product which has a successful record of reliable service in similar installations for a minimum of five (5) years.

2. All valves of same type and duty shall be furnished by a single manufacturer.

B. Standards

1. ANSI
2. AISI
3. SSPC
4. AWWA

C. Warranty: Provide manufacturer's warranty in accordance with the General Conditions and Section 01740: Warranties and Bonds.

D. Equipment Manufacturers

1. Equipment manufacturers are named in each individual valve specification and where applicable shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications, or approved equal.

2. The naming or reference to a specific manufacturer does not indicate that the manufacturer's standard equipment is acceptable in lieu of the specified component features. This reference is only an indication that the named manufacturers may have the capability of supplying the equipment as specified.

1.03 SUBMITTALS

A. Materials and Shop Drawings: Copies of all materials required to establish compliance with the Specification shall be submitted in accordance with the provisions of the General Conditions and Section 01340: Shop Drawings, Working Drawings, and Samples. Submittals shall include at least the following:

1. Certified shop drawings showing all important details of construction, dimensions (including laying length), and weight.

2. Descriptive literature, bulletins, and/or catalogs showing all valve parts, and describing material of construction by material and specification, e.g., AISI.

3. Schedule of valves, referencing each valve type, end connections and actuators to the proposed location/application on the Drawings.

4. Valve coatings and linings, if any.

5. Valve Tag Identification Schedule (see PART 2).

6. See individual sections for additional requirements.

B. Operation and Maintenance Manuals: For all valves furnished under this Section, the Contractor shall submit operation and maintenance manuals in accordance with Section 01730: Operating and Maintenance Data, to include the following:

1. Equipment function.
2. Description.
3. Normal and limiting operating characteristics.
4. Installation instructions (assembly, alignment and adjustment procedures).
5. Operation instructions (normal start-up and shut-down procedures, normal operating conditions and emergency situations).
6. Lubrication and maintenance instructions.
7. Troubleshooting guide.
8. Parts list and predicted life of parts subject to wear.
9. Drawings - cross-sectional view, assembly diagrams.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials and Equipment

1. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed.

2. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

3. Finished surfaces of all exposed openings shall be protected by wooden blanks, strongly built and securely bolted thereto.

4. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

5. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

6. Each box or package shall be properly marked to show its net weight in addition to its contents.

B. Storage of Materials and Equipment

1. Store valves and accessories in an area on the construction site protected from weather, moisture, or possible damage.

2. Do not store valves or accessories directly on the ground or in the open.

C. Handling of Materials and Equipment

1. Handle valves and accessories to prevent damage of any nature.

2. Carefully inspect all materials for:

a. Defects in workmanship and materials.
b. Removal of debris and foreign material in valve openings and seats.
c. Proper functioning of all operating mechanisms.
d. Tightness of all nuts and bolts.

1.05 SPECIAL TOOLS AND SPARE PARTS

A. Special Tools

1. All special tools required for normal operation and maintenance shall be provided in accordance with Division 1.

2. One (1) each tee handle operator shall be provided for every three (3) buried valves.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials shall be as indicated in specific sections, or on the Drawings, and compatible with intended use.

B. Valves shall have the name of the manufacturer and the size of the valve cast or molded onto the valve body or bonnet or shown on a permanently stainless steel attached plate.

C. Bolts, washers, nuts, and gaskets for flanged valves shall be as described in the specific piping sections.

D. Coat metal valves located above ground or in vaults and structures the same as the adjacent piping. Apply the specified prime coat at the place of manufacture. Apply finish coat in field. Finish coat shall match the color of the adjacent piping. All prime and finish coats shall be in compliance with Division 9.

2.02 VALVE IDENTIFICATION

A. On all valves except shut-off valves located at a fixture or piece of equipment, the Contractor shall provide a coded and numbered tag attached with brass chain and/or brass "S" hooks.

1. Tag types
   a. Tags for valves on pipe and tube lines conducting hot medium (steam, condensate, hot water, air, etc.) shall be brass or anodized aluminum.
   b. Tags for all other valves shall be color plastic.
   c. Colors for aluminum and plastic tags shall, where possible, match the color code of the pipe line on which installed.
   d. Square tags shall be used to indicate normally closed valves and round tags shall indicate normally open valves.

2. Coding: In addition to the color coding, each tag shall be stamped or engraved with wording or abbreviations to indicate the line service. All color and letter coding shall be approved by the Engineer.

3. Manufacture: Tags shall be as manufactured by Seton Name Plate Corporation, Floy Tag & Manufacturing Co. or approved equal.

4. Valve Schedule: the Contractor shall provide a typewritten list of all tagged valves giving tag color, shape, letter code and number, the valve size, type, use and general location within building.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install valves and accessories in strict accordance with manufacturer's instructions and recommendations, as shown on the Drawings and/or as directed by the Engineer.

B. Carefully erect all valves and support them in their respective positions free from distortion and strain.

C. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

D. Support all valves connected to pumps and equipment, and in piping systems that cannot support valves.

E. Repair any scratches, marks and other types of surface damages, etc., with original prime coating as supply by the factory.

F. Apply finish coating in accordance with Division 9.

3.02 INSPECTION AND TESTING

A. Check and adjust all valves and accessories for smooth operation.

B. Test valves for leakage at the same time that the connecting pipelines are tested. Protect or isolate any parts of valves, operators, or control and instrumentation systems whose pressure rating is less than the pressure tests.

C. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseat or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints.

END OF SECTION

SECTION 15101

GATE VALVES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Scope of Work: Furnish and install gate valves of the type and size and in the location as shown on the Drawings and/or specified herein.

B. General Design:

1. 2-inches and smaller above ground pressure Class 125 bronze.

2. 2½ inches and larger, above ground, iron body, bronze mounted, non-rising stem (NRS).

3. Below ground, iron body, bronze mounted, NRS. Use reducers as necessary to accommodate small buried piping.

4. Comply with the requirements of Section 15100.

1.02 QUALITY ASSURANCE

A. Qualifications: See Section 15100.

B. Standards: See Section 15100.

C. Warranty: See Section 15100.

D. Equipment Manufacturers: Manufacturers shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications.

1.03 SUBMITTALS

A. General: Submittals shall be in accordance with Section 15100.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. General: Product delivery, storage and handling shall be in accordance with Section 15100.

1.05 SPECIAL TOOLS AND SPARE PARTS

A. General: Provide special tools in accordance with Section 15100.

PART 2 - PRODUCTS

2.01 GENERAL

A. General: Valves shall comply with PART 2 - Products of Section 15100.

2.02 MATERIALS

A. General Service 2-inches and smaller, above ground:

1. Bronze construction - 125 pound steam.

2. Union bonnet.

3. Inside screw, rising stem or non-rising stem.

4. Solid disc, taper wedge.

5. End connections:

a. Threaded

b. Or solder ends for copper pipe systems

6. Malleable iron, or steel hand wheel.

B. General Service – 2-1/2 inches through 30 inches:

1. Gate valves shall be resilient seat gate valves, manufactured to meet or exceed the requirements of AWWA C509, latest revision. Valves shall have an unobstructed waterway equal to or greater than the full nominal diameter of the valve.

2. Cast iron body, bonnet and bonnet cover, ASTM A126 Class B, 250 psi working pressure. 2-inch wrench nut shall be provided for operating the valve.

3. Non-rising stem, made of cast, forged or rolled bronze as specified in AWWA C509. Two stem seals shall be provided and shall be of the o-ring type. The stem nut shall be independent of the gate.

4. Ductile iron gate with vulcanized EPDM synthetic rubber coating (resilient seated). Zero leakage at test and normal working pressure when installed with the line flow from either direction.

5. Valves for buried service shall have mechanical joints conforming to ANSI A21.11, above ground service joints shall be flanged conforming to ANSI B16.1 for Class 125 flanges.

6. All ferrous surface inside and outside shall have a fusion-bonded epoxy coating in accordance with AWWA C550.

7. Valves 16-inches and larger shall have side actuators.

C. General Service - Greater than 30 inches: Valves shall meet the requirements of 2.01 and 2.02.B except as specified otherwise below:

1. Operator shall be bevel or spur geared.

2. In horizontal installations, valves shall be equipped with bevel gear suitable for burled service.

3. Valves 42-inch and greater shall be provided with by-pass gate valve.

4. Working pressure shall be a minimum of 150 psi.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install valves with stem position vertical, unless shown otherwise.

B. Allow sufficient clearance around valve operator for proper operation.

C. Install in accordance with "Valve and Specialties - General" Section 15100.

END OF SECTION

SECTION 15103

BUTTERFLY VALVES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Scope of Work: Furnish and install butterfly valves of the type and size and in the location as shown on the Drawings and/or specified herein.

B. General Design:

1. 3-inches and larger, iron body bronze mounted.

2. Butterfly valves shall be fully operational and disc shall not interfere with adjacent piping/fittings.

3. Comply with the requirements of Section 15100.

1.02 QUALITY ASSURANCE

A. Qualifications: Comply with Section 15100.

B. Standards: Comply with Section 15100.

C. Warranty: Comply with Section 15100.

D. Equipment Manufacturers:

1. Comply with Section 15100.

2. Valves shall be manufactured by:
   a. Henry Pratt Co.
   b. Dezurik
   c. Clow

1.03 SUBMITTALS: Submittals be in accordance with Section 15100.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING: Product delivery, storage and handling shall be in accordance with Section 15100.

1.05 SPECIAL TOOLS AND SPARE PARTS: Provide special tools in accordance with Section 15100.

PART 2 - PRODUCTS

2.01 GENERAL

A. Valves shall meet applicable parts of Section 15100.

B. AWWA Water Service: (Potable)

1. Equal or exceed requirements of AWWA C-504, Class 150B for frequent operation. Conform to Underwriters' Laboratories classification in accordance with ANSI/ NSF 61.

2. Suitable for direct burial when required.

3. Bubble-tight shutoff at 150 psi working pressure.

4. Body: Cast or ductile iron ASTM - A126, Class B.

5. Disc: Bronze, cast iron, ductile iron, Ni-resist per manufacturer's standard and valve size. Disc shall not interfere with adjacent piping when operated.

6. Valve Shaft: Valves shafts shall be turned, ground and polished, constructed of 18-8 stainless steel and in compliance with AWWA C504 and designed for both torsional and sheering stresses when the valve is operated under its greatest dynamic or seating torque. Shaft shall be of either a one-piece unit extending full size through the valve disc and valve bearing or it may be of a stub shaft design as applicable.

7. Valve Seat: Natural or synthetic rubber or elastomer material as described in AWWA C504. The valve seats shall be field adjustable and replaceable without dismounting operator disc or shaft and without removing the valve from the line. All retaining segments and adjusting devices shall be of corrosion resistant material.

8. Bearings: Shaft bearings shall be of self-lubricating corrosion resistant sleeve type as specified in AWWA C504.

9. Valve connections shall be as shown on the Drawings or generally as follows:

Acceptable Valve Connections:

a. Ground buried: Mechanical joints, restrained where shown on the Drawings, ANSI A21.11. Where used in existing steel piping, valves shall be flanged.
b. Exposed: Flanged (125 lb. standard), ANSI B16.1, valve neck length shall be sufficient to allow for flange clearance.

10. Testing: All valves shall be hydrostatic and leak tested in accordance with AWWA C504.

11. Working pressure: 150 psi unless otherwise shown on the Drawings.

12. Operator:
    a. Ground buried: Wrench nut (two-inch), T-handle wrench, valve box with cover for valves 6 inches in diameter or smaller. Worm gear (AWWA C504), wrench nut, T-handle wrench valve box with cover for valves 8 inches in diameter and greater.
    b. Exposed: Lever activator with infinite lockable positioning capability standard on 6-inch and smaller valves, and worm gear with handwheel for valves 8 inches in diameter or greater.

13. Internal and external surfaces shall be shop painted with two (2) coats of asphalt varnish (4 mils per coat) except for bearing surfaces.

PART 3 - EXECUTION

3.01 INSTALLATION: Install in accordance with manufacturer's recommendations and Section 15100.

END OF SECTION

SECTION 15116

VALVE BOXES

PART 1 - GENERAL

1.01 SCOPE OF WORK: Furnish and install valve boxes of type and size and in the location shown on the Drawings and as specified herein.

1.02 QUALITY ASSURANCE

A. Qualifications: See Section 15100.

B. Standards: All curb boxes shall be the product of one manufacturer.

C. Warranty: See Section 15100.

D. Equipment Manufacturers: Manufacturers shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. All buried valves shall have cast iron, three (3) piece valve boxes. Valve boxes shall be provided with suitable heavy bonnets and to extend to such elevation at or slightly above the finished grade surface as directed by the Engineer.

B. The barrel shall be screw type, having 5-1/4 inch diameter shaft. The upper section shall have a flange at the bottom having sufficient bearing area to prevent settling and shall be complete with cast iron covers.

C. Covers shall have "WATER" cast into the top for all water mains and "SEWER" cast into the top of all wastewater force mains and "REUSE" cast into the top of all reclaimed water mains.

D. All valves shall have actuating nuts extended to top of valve boxes.

E. Valve box assemblies are required for any size main that is six feet or greater below finished grade or if mains are greater than 12-inches in diameter. The valve box assembly shall be one complete unit composed of the valve box and extension stem that attaches to the valve body. All moving parts of the extension stem shall be enclosed in a

housing to prevent contact with the soil. The valve box assembly shall be adjustable to accommodate variable trench depths six feet and greater as shown on the Drawings.

F. The stem assembly shall be of a telescoping design that allows for variable adjustment length. The material shall be galvanized square steel tubing. The stem assembly shall have a built-in device that prevents the stem assembly from disengaging at its fully extended length. The extension stem shall be capable of surviving a torque test to 1,000 ft-lb without failure.

G. Valve boxes shall have locking lids, utilizing a five sided nut with a special wrench needed to open. Valve lids shall be as shown on the Drawings.

H. Valve collars shall be made of a fiberglass reinforced concrete polymer material manufactured to the specifications as shown on the Drawings utilizing a test station box made into the valve collar for placement of the locating wire. The locating wire shall be 10-gauge single strand solid core copper wire with insulation. The color of the insulation shall be the same color as the color code for the pipe being installed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as shown on the Drawings and/or as directed by the Engineer.

B. When installation is complete, no pressure shall be exerted by the valve box on either the valve or the pipe.

END OF SECTION

SECTION 15120

PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Scope of Work: This section includes materials and installation of the miscellaneous piping specialties.

B. General Design:

1. Comply with Section 15100, Article 1.01.B.1, 2 and 3.
2. Specialties shall have a working pressure rating equal to or greater than the piping installed in.

1.02 QUALITY ASSURANCE

A. Qualifications: Comply with Section 15100.

B. Standards: Comply with Section 15100.

C. Warranty: Comply with Section 15100.

D. Equipment Manufacturers: See PART 2.

1.03 SUBMITTALS: Submittals be in accordance with Section 15100.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING: Product delivery, storage and handling shall be in accordance with Section 15100.

1.05 SPECIAL TOOLS AND SPARE PARTS: Provide special tools in accordance with Section 15100.

PART 2 - PRODUCTS

2.01 SOLENOID VALVES: Solenoid valves shall be design for not less than 150 psi water working pressure and shall be installed where shown. Electrical operators for solenoid valves shall be in accordance with electrical drawings. Valves shall be two-way pattern, screwed, brass-body type, ASCO No. 8210 through 8223.

2.02 TAPPING VALVES AND SLEEVES: Tapping valves and sleeves shall be as manufactured by:

A. See Specification Section 15128.

B. Tapping Valves shall be resilient seated. Tapping valves manufacturer shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications. Tapping valves shall include flush port, piped to above grade with isolation valve. Tapping valve shall hold in both directions with no leaks regardless of pressure differential across the valve.

C. Tapping sleeve for ductile iron pipe shall be mechanical joint; with tapping valves which outlet to a flanged connection for the above ground applications, and outlet to a mechanical joint connection for buried pipe taps. Exact O.D. of pipe to be tapped shall be field measured prior to ordering sleeve. Tapping sleeves manufacturer shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications.

2.03 HOSE BIBS: Hose bibs shall be equal to Watts No. SC-3 or SC-4 of the size shown on the Drawings.

2.04 CORPORATION STOPS: Corporation stops shall be threaded on the inlet side and the outlet side fitted with connections to suit connecting pipe or tubing. Manufacturer shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications or approved equal.

2.05 CURB STOPS: Curb stops shall be ball type. Manufacturer shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications or approved equal.

2.06 QUICK CONNECT COUPLINGS FOR WATER SERVICE: Quick connect couplings shall be Model 633-F hose shank adapter and Model 633-C hose shank coupler as manufactured by Dover Corporation OPW Division, Cincinnati, Ohio, equal by Ever-tite Coupling Co., Inc., New York, New York or equal.

2.07 QUICK CONNECT COUPLINGS FOR CHEMICAL SERVICE: Quick connect couplings for Chemical Service shall be male adaptor/female thread type. Provide dust cap and security chain with each coupler. Bodies shall be glass fiber reinforced polypropylene. Gaskets shall be Teflon. Adaptors shall be Ever-tite Coupling Co. Port A/DC, Banjo Corporation Male Adapter/Female Thread with dust cap, Murray Equipment Inc., Style A/DC, or equal.

2.08 SERVICE SADDLES: Service saddles shall be of the double-strap type. Straps and bodies shall be bronze or silicon bronze. Tap sizes on the outlet shall be 3/4-inch through 2 inches to accommodate the connecting piping or corporation stops. Manufacturer shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications or approved equal.

2.09 STRAINERS FOR WATER SERVICE: Strainers shall be installed as shown on the Drawings and shall be of the "Y" type. Strainers shall have bronze bodies with a removable bronze screen and shall be as manufactured by Mueller Steam, Mineola, New York, Watts Regulator Company, Lawrence, Mass., or equal.

PART 3 - EXECUTION

3.01 INSTALLATION: Install piping specialties of the sizes and types in accordance with the manufacturer's instructions, and in the locations shown on the Drawings or specified herein.

END OF SECTION

SECTION 15126

PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment and incidentals and install pipe hangers, supports, concrete inserts, and anchor bolts including all metallic hanging and supporting devices for supporting exposed piping.

B. Related Work Described Elsewhere:

1. Concrete is included in Division 3.

2. Metal fabrications are included in Section 05500.

3. Painting is included in Section 09900.

4. Pipe and fittings are included in respective sections of Division 15.

5. Mechanical - General Requirements: Section 15000.

C. General Design (Not Applicable)

1.02 QUALITY ASSURANCE

A. Hangers and supports shall be of approved standard design where possible and shall be adequate to maintain the supported load in proper position under all operating conditions. The minimum working factor of safety for pipe supports shall be five (5) times the ultimate tensile strength of the material, assuming 10 feet of water filled pipe being supported.

B. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, the Contractor shall submit a certification stating that such requirements have been complied with.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Submit to the Engineer for approval, as provided in the General Conditions and Section 01340, shop drawings of all items to be furnished under this Section.

2. Submit to the Engineer, for approval, samples of all materials specified herein.

1.04 PRODUCT DELIVERY STORAGE AND HANDLING

A. The equipment provided under this section shall be shipped, handled and stored in accordance with the Manufacturer's written instructions, and in accordance with Section 01600 - Material and Equipment.

1.05 WARRANTY AND GUARANTEES

A. Provide equipment warranty in accordance with Section 01740 - Warranties and Bonds.

PART 2 - PRODUCTS

2.01 GENERAL

A. All pipe and tubing shall be supported as required to prevent significant stresses in the pipe or tubing material, valves, and fittings and to support and cure the pipe in the intended position and alignment. All supports shall be designed to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as equipment, pipe, and personnel contact. All pipe supports shall be approved prior to installation.

B. The Contractor shall select and design all piping support systems within the specified spans and component requirements. Structural design and selection of support system components shall withstand the dead loads imposed by the weight of the pipes filled with water, plus any insulation. Commercial pipe supports and hangers shall have a minimum safety factor of 5.

C. No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the details. The absence of pipe supports and details on any drawings shall not relieve the Contractor of the responsibility for providing them throughout the plant.

D. All support anchoring devices, including anchor bolts, inserts and other devices used to anchor the support onto a concrete base, roof, wall or structural steel works, shall be of the proper size, strength and spacing to withstand the shear and pullout loads imposed by loading and spacing on each particular support.

E. All materials used in manufacturing hangers and supports shall be capable of meeting the respective ASTM Standard Specifications with regard to tests and physical and chemical properties, and be in accordance with MSS SP-58.

F. Hangers and supports shall be spaced in accordance with ANSI B31.1.0 except that the maximum unsupported span shall not exceed 10 feet unless otherwise specified herein.

G. Unless otherwise specified herein, pipe hangers and supports shall be as manufactured byAnvil International, Inc., Carpenter and Patterson, Inc., or equal. Any reference to a specific figure number of a specific manufacturer is for the purpose of establishing a type and quality of product, and shall not be considered as proprietary. Any item comparable in type, style, quality, design and performance will be considered for approval.

2.02 MATERIALS AND EQUIPMENT

A. Pipe Hangers and Supports for Metal Pipe:

1. Suspended single pipes shall be supported by hangers suspended by steel rods from galvanized concrete inserts, beam clamps, or ceiling mounting bolts as follows:

a. Hangers

Pipe Size, Inches	Anvil Fig. No.
Less than 1/2	138R
1/2 through 1	97C
1-1/4 through 4	104
6 through 12	590
14 through 30	171

b. Hanger rods shall be rolled steel machine threaded with load ratings conforming to ASTM Specifications and the strength of the rod shall be based on root diameter. Hanger rods shall have the following minimum diameters:

Pipe Size, Inches	Min. Rod Diameter, In.
Less than 2-1/2	3/8
2-1/2 to 3	1/2
4	5/8
6	3/4
8 to 12	7/8
14 to 18	1

c. Where applicable, structural attachments shall be beam clamps. Beam clamps, for rod sizes 1/2-inch through 3/4-inch shall be equal to Anvil Fig. No. 229, and for rod sizes 7/8-inch through 1-1/4 inches shall be equal to Anvil Fig. No. 228, or equal.

d. Concrete inserts for pipe hangers shall be; continuous metal inserts designed to be used in ceilings, walls or floors, spot inserts for individual pipe hangers, or ceiling mounting bolts for individual pipe hangers and shall be as manufactured by Unistrut Corp., Wayne, Michigan; Carpenter and Patterson, Inc., Laconia, New Hampshire; Richmond or equal and shall be as follows:

i. Continuous concrete inserts shall be used where applicable and/or as shown on the Drawings and shall be used for hanger rod sizes up to and including 3/4-inch diameter. Inserts to be used where supports are parallel to the main slab reinforcement shall be Series P3200 by Unistrut Corp., Fig 1480 Type 2 by Carpenter and Patterson, Inc., or equal. Inserts to be used where supports are perpendicular to the main slab reinforcement shall be Series P3300 by Unistrut Corp., Fig. 1480 Type I by Carpenter and Patterson, Inc. or equal.

ii. Spot concrete inserts shall be used where applicable and shall be used for hanger sizes up to and including 7/8-inch diameter. Inserts shall be Fig. 650 by Carpenter and Patterson, Inc. for hanger rod sizes 1/2-inch through and including 3/4-inch, and Fig. 266 by Carpenter and Patterson Inc., for 7/8-inch hanger rods.

iii. Ceiling mounting bolts shall be used where applicable and be for hanger rod sizes l-inch through and including 1-1/4 inches and shall be Fig. 104M as manufactured by Carpenter and Patterson, Inc., or equal.

e. All pipe hangers shall be capable of vertical adjustment under load and after erection. Turnbuckles, as required and where applied, shall be equal to Anvil Fig. No. 230.

2. Wall or column supported pipes shall be supported by welded steel brackets equal to Anvil Fig. 194, 195 and 199 as required, for pipe sizes up to and including 20-inch diameter. Additional wall bearing plates shall be provided where required.

   a. Where the pipe is located above the bracket, the pipe shall be supported by an anchor chair and U-bolt assembly supported by the bracket for pipes 4 inches and larger and by a U-bolt for pipes smaller than 4 inches. Anchor chairs shall be equal to Carpenter Patterson Fig. No. 127. U-bolts shall be equal to Anvil Fig. No. 120 and 137.

   b. Where the pipe is located below the bracket, the pipes shall be supported by pipe hangers suspended by steel rods from the bracket. Hangers and steel rods shall be as specified above.

3. Floor supported pipes 3-inches and larger in diameter shall be supported by either cast-in-place concrete supports or adjustable pipe saddle supports as directed by the Engineer. In general, concrete supports shall be used when lateral displacement of the pipes is probable (unless lateral support.l provided), and adjustable pipe saddle type supports shall be used where later displacement of pipes is not probable.

   a. Each concrete support shall conform to the details shown on the Drawings. Concrete shall be poured after the pipe is in place with temporary supports. Concrete piers shall conform accurately to the bottom 1/3 to 1/2 of the pipe. Top edges and vertical corners of each concrete support shall have l-inch bevels. Each pipe shall be secured on each concrete support by a wrought iron or steel anchor strap anchored to the concrete with cast-in-place bolts or with expansion bolts. Where directed by the Engineer, vertical reinforcement bars shall be grouted into drilled holes in the concrete floor to prevent overturning or lateral displacement of the concrete support. Unless otherwise approved by the Engineer, maximum support height shall be five (5) feet.

   b. Concrete piers used to support base elbows and tees shall be similar to that specified above. Piers may be square or rectangular.

   c. Each adjustable pipe saddle support shall be screwed or welded to the corresponding size 150 pound companion flanges or slip-on

welding flanges respectively. Supporting pipe shall be of Schedule 40 steel pipe construction. Each flange shall be secured to the concrete floor by a minimum of two (2) expansion bolts per flange. Adjustable saddle supports shall be equal to Anvil Fig. No. 264. Where used under base fittings, a suitable flange shall be substituted for the saddle.

4. Vertical piping shall be supported as follows:

   a. Where pipes change from horizontal to vertical, the pipes shall be supported on the horizontal runs within 2 feet of the change in direction by pipe supports as previously specified herein.

   b. For vertical runs exceeding 15 feet, pipes shall be supported by approved pipe collars, clamps, brackets, or wall rests at all points required to insure a rigid installation.

   c. Where vertical piping passes through a steel floor sleeve, the pipe shall be supported by a friction type pipe clamp which is supported by the pipe sleeve. Pipe clamps shall be equal to Anvil Fig. 262.

5. Anchor bolts shall be equal to Kwik-Bolt as manufactured by the McCullock Industries, Minneapolis, Minnesota, or Wej-it manufactured by Wej-it Expansion Products, Inc., Bloomfield, Colorado.

6. All rods, hangers, inserts, brackets, and components shall be furnished with galvanized finish.

B. Pipe Hangers and Supports for Plastic Pipe:

1. Single plastic pipes shall be supported by pipe supports as previously specified herein.

2. Multiple, suspended, horizontal plastic pipe runs, where possible, and rubber hose shall be supported by ladder type cable trays such as the Electray Ladder by Husky-Burndy, the Globetray by the Metal Products Division of United States Gypsum, or equal. Ladder shall be of mild steel construction. Rung spacing shall be approximately 18 inches for plastic pipe and 12 inches for rubber hose. Tray width shall be approximately 6-inch for single runs of rubber hose and 12 inches for double runs of rubber hose. Ladder type cable trays shall be furnished complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc. required for a complete support system. Individual plastic pipes shall be secured to the rungs of the cable tray by strap clamps or fasteners equal to Globe Model M-CAC, Husky-Burndy Model SCR or approved equal. Spacing between

clamps shall not exceed 9 feet. The cable trays shall provide continuous support along the length of the pipe.

3. Individual clamps, hangers, and supports in contact with plastic pipe shall provide firm support but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

C. Pipe Supports for Small Diameter PVC and Steel Pipe:

1. Small diameter Schedule 80 PVC piping 3-inches in diameter and smaller, and steel piping 2-inches in diameter and smaller shall be supported with "SUSPORT" system arrangements as manufactured by Universal Suspension Systems Inc. of Gillette, New Jersey or an equal approved by the Engineer. Clamping halves for the pipe support shall be manufactured of molded polypropylene and shall support and fit closely for 360° around the pipe. To support piping carrying non-corrosive fluids or gases and located in noncorrosive, indoor environments, all hardware for the "SUSPORT" system shall be nickel chrome plated carbon steel. To support piping carrying corrosive fluids or gases, piping located in corrosive environments or piping located outdoors, all hardware for the system shall be manufactured of Type 304 stainless steel.

2. In some cases, to adequately support small diameter PVC or steel piping, a metal frame support structure may be required for support of the "SUSPORT" system specified above. Where required, metal frame support structures shall be constructed using channels, fittings, brackets, hardware and other accessories as manufactured by B-Line Systems, Inc. of Highland, Illinois, or an equal approved by the Engineer. If located in indoor, non-corrosive environments, the materials for the frame structure shall be carbon steel with an epoxy coating applied by a cathodic, electro-deposition process which is equal to "Dura-a-Green" by B-Line Systems, Inc. For corrosive or outdoor environments, the materials for the frame structure be Type 316 stainless steel unless otherwise noted on the Drawings. Hardware used to construct the frame support structure shall be cadmium plated for carbon steel supports or Type 316 stainless steel for stainless steel supports.

3. Pipe supports for small diameter PVC and steel piling shall be located wherever necessary in the opinion of the Engineer to adequately support the pipe, however, they shall have a maximum spacing as specified below for straight pipe runs. Adequate supports shall especially be used adjacent to valves and fittings in pipelines. The following table is based on spacing requirements for Schedule 80 PVC or Standard Weight (Schedule 40) steel pipe carrying a fluid with a Specific Gravity of 1.0 at a temperature not exceeding 120°F. Support spacing for PVC or steel piping carrying fluids

with Specific Gravities or temperatures exceeding those stated above shall be approved by the Engineer.

Nominal Pipe Diameter, Inches	Support Spacing, Feet PVC Pipe	Steel Pipe
1/2"	3.5	4.5
3/4"	4.0	5.0
1"	4.5	5.5
1-1/4"	5.0	6.5
1-1/2"	5.0	7.5
2"	5.5	8.0
2-1/2"	5.5	-
3"	6.0	-

2.03 ACCESSORIES (Not Applicable)

2.04 SPARE PARTS (Not Applicable)

2.05 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 PREPARATION

A. Prior to prime coating, all pipe hangers and supports shall be thoroughly clean, dry and free from all mill-scale, rust, grease, dirt, paint and other foreign substances to the satisfaction of the Engineer.

B. All submerged pipe supports shall be prime coated with Koppers 654 Epoxy Primer or approved equal. All other pipe supports shall be prime coated with Rustinhibitive Primer No. 621 as manufactured by Koppers Company, Inc., Pittsburgh, Pa., or equal.

C. Finish coating shall be compatible with the prime coating used and shall be applied as specified in Section 09900 - Painting.

3.02 INSTALLATION

A. All pipes, horizontal and vertical, shall be rigidly supported from the building structure by approved supports. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or specified herein. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless it

is so indicated on the Drawings, or specifically directed or authorized by the Engineer.

B. All pipe supports shall be designed with liberal strength and stiffness to support the respective pipes under the maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement, and pressure forces, thermal expansion and contraction, vibrations, and all probable externally applied forces. Prior to installation, all pipe supports shall be approved by the Engineer.

C. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings, and sleeve type couplings and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.

D. Pipe supports shall be provided as follows:

1. Cast iron and ductile iron shall be supported at a maximum support spacing of 10 feet, 0-inches with minimum of one support per pipe section at the joints.

2. All vertical pipes shall be supported at each floor or at intervals of at least 15 feet by approved pipe collars, clamps brackets or wall rests, and at all points necessary to insure rigid construction.

E. Effects of thermal expansion and contraction of the pipe shall be accounted for in pipe support selection and installation.

F. Inserts for pipe hangers and supports shall be installed on forms before concrete is poured. Before setting these items, all Drawings and figures shall be checked which have a direct bearing on the pipe location. Responsibility for the proper location of pipe supports is included under this Section.

G. Continuous metal inserts shall be embedded flush with the concrete surface.

H. Standard Pipe Supports:

1. Horizontal Suspended Piping:

a. Single Pipes: Adjustable swivel-ring, splint-ring, or clevis hangers.

b. Grouped Pipes: Trapeze hanger systems.

c. Furnish galvanized steel protection shield and oversized hangers for all insulated pipe.

d. Furnish precut sections of rigid insulation with vapor barrier at hangers for all insulated pipe.

2. Horizontal Piping Supported From Walls:

a. Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.

b. Stacked Piping:

1) Wall mounted framing system and clips acceptable for piping smaller than 3-inch minimal diameter.

2) Piping clamps which resist axial movement of pipe through support not acceptable.

c. Wall mounted piping clips not acceptable for insulated piping.

3. Horizontal Piping Supported From Floors:

a. Stanchion Type:

1) Pedestal type; adjustable with stanchion, saddle, and anchoring flange.

2) Use yoke saddles for piping whose centerline elevation is 18 inches or greater above the floor and for all exterior installations.

3) Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.

b. Floor Mounted Channel Supports:

1) Use for piping smaller than 3-inch nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.

2) Attach channel framing to floors with anchor bolts.

3) Attach pipe to channel with clips or pipe clamps.

c. Concrete Cradles: Use for piping larger than 3-inch along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.

4. Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.

5. Standard Attachments:

a. To Concrete Ceilings: Concrete inserts.

b. To Steel Beams: I-beam clamp or welded attachments.

c. To Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.

d. To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.

6. Existing Walls and Ceilings: Install as specified for new construction, unless shown otherwise.

3.03 INSPECTION AND TESTING (Not Applicable)

3.04 START-UP AND INSTRUCTION (Not Applicable)

END OF SECTION

SECTION 15128

WET TAPS & TEMPORARY LINE STOPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: The work included under this Section consists of work performed on pressurized pipelines by the approved wet tap and line stop method and the immediate installation of various piping, valves, and instrumentation in accordance with the Contract Documents.

B. The Contractor shall take all safety measures necessary to prevent shutting down or depressurizing the water main system and shall coordinate all work to accommodate the needs of the existing treatment facility operations. Interruptions to the facility's operations will not be permitted during wet tap or line stop activities; however the Contractor shall notify the Owner in advance of such activities in accordance with Section 01041 of the Contract Documents.

1.02 QUALITY ASSURANCE

A. The Contractor shall employ the services of a wet tap and line stop specialist to perform wet taps and line stops as shown the Drawings and necessary in the completion of the work. The specialist shall be experienced in performing such work on potable water steel pipelines with cement linter, and shall have previously performed at minimum of five (5) line stops of equal or greater size on potable water systems within the last five (5) years to be considered qualified for this project.

B. Wet Tap and Line Stop Technician Qualifications:

1. Wet tap and line stop technician actually operating the machinery shall have a minimum of five (5) years of continuous employment history with the wet tap and line stop specialist. The Contractor shall be required to furnish employment history for this technician along with a safety and other operational training summary.

C. The only approved wet tap and line stop specialists:

1. TDW Services

2. International Flow Technologies

3. EA Tapping Services

1.03 SUBMITTALS

A. Submit shop drawings in accordance with the Section 01340: Shop Drawings and Submittals and the following.

B. Qualifications for the wet tap and line stop specialist, including representative projects and technician qualifications as required in paragraph 1.02, A and B above.

C. Contractor shall submit a plan outlining the estimated schedule, method of construction and restoration of the wet taps and line stops. This shall include, but is not limited to detailed drawings and a written description of the entire construction procedure to install, bypass, and reconnect the water main.

D. Contractor shall submit certification of workmen training for installing wet taps and line stop fittings.

E. Contractor shall provide submittals for all materials and equipment to be installed during the performance of the work.

1.04 PRODUCT, DELIVERY, STORAGE AND HANDLING

A. If proposed or existing pipe and fittings become damaged before or during installation, it shall be repaired as recommended by the manufacturer or replaced as required by the Engineer or Owner at the Contractor's expense, before proceeding further.

B. The Owner reserves the right to reject the work performed on any portion of the project in which there is evidence that the materials have not been handled in accordance with the manufacturer's recommendations.

1.05 WARRANTY AND GURANTEES

A. The Contractor is responsible for replacing any portion of the work found to be installed in a way that stresses the material beyond the manufacturer's recommendations.

B. The Contractor shall provide all warranties and guarantees relative to workmanship and materials as required by the Contract Document, General Conditions and supplementary Conditions.

PART 2 – PRODUCTS

2.01 GENERAL

A. The equipment used in the installation of wet taps and line stops installation shall be of adequate commercial size and satisfactory working condition for safe operation, and will be subject to approval by the Engineer. Such approval, however, will not relieve the Contractor of the responsibility for making a satisfactory installation satisfying all criteria of the project.

B. The Contractor shall provide all materials for completing the installation and for adequate protection of the work.

C. Line stop and wet tap minimum pressure rating shall be equal to that of the pipeline in which they are to be installed.

2.02 MANUFACTURER TESTING

A. Test for compliance with this Specification shall be made as specified herein and in accordance with the applicable ASTM Specification. A certificate with this inspection shall be furnished upon request by the manufacture for all material furnished under this Specification. Equipment, valves, and fittings may be rejected if they fail to meet any requirements of this Specification.

2.03 FITTINGS

A. The wet tap fitting to be used for this type work shall be manufactured in two sections. The back (bottom) section will be of the full encirclement type and conform to the measured pipe outside diameter. The front (top) section will also be full encirclement type with a factory installed nozzle and flange outlet. Wet tapping saddles will be fabricated from approved carbon steel materials. The body run sections (top and bottom) shall be made of ASTM A-283 grade steel as a minimum. Steel run sections will conform to and re-enforce the existing pipe.

B. Fittings will have a recess for installation of a Buna-N rubber gasket around the hot tapping outlet. Bolts and nuts shall be a corrosion resistant alloy material per AWWA C-111 and ANSI 21.11.

C. A ¾" female NPT threaded test outlet will be placed into the nozzle branch outlet, at the factory, for the purposes of site pressure testing after the fitting has been installed around the pipe.

D. Outlets in sizes 4" to 60" in diameter shall have a minimum pressure rating of 150 psi.

E. Body:

1. ASTM A 283 grade C or ASTM A-36. Saddle plate thickness shall be in accordance with the design criteria for the entire fitting. The minimum wall thickness for saddle plates shall be 0.375". All welding of materials shall be in accordance with applicable code standards. Saddle plates shall be designed to permit longitudinal bolting of the top and bottom halves around the pipe.

F. Hot Tap Nozzle

1. Nozzles attached to the saddle plates shall be constructed of A-106 grade B steel or ASTM A-283 or A-36 steel. All weldments will be suitably stressed relieved when required by code or by common practice. Nozzle thickness shall be a minimum of standard steel pipe size or schedule 40 pipe wall thickness in compliance with the maximum working pressure of the system.

G. Nozzle to Pipe Sealing Gasket

1. Shall be molded from elastomeric compounds that resist compression set and are compatible with potable water in the temperature range of 32 to 140 degrees F. Buna-N rubber is recommended for use with potable water.

H. Flanges Used For Line Plugging

1. All flanges used for line plugging will be manufactured from ASTM- A-105 grade or equal.

2. Flanges will comply with ASME B16.5 in sizes up to 12". Completion plug locking mechanisms shall consist of ring segments or steel leaves that lock from or into the flange bore.

I. Point Loaded Set Screw

1. The use of point loaded set screw type locks shall be strictly prohibited.

J. Completion Plugs Used For Line Plugging

1. Completion plugs used for line plugging shall be manufactured from steel plate, ASTM A-36 grade material. Completion plugs shall be constructed in such a manner that an "O" ring pressure activated device will permit sealing the completion plug to the flange bore thus permitting the safe recovery of the temporary valve utilized for the line plugging operation.

Locking grooves or locking leaves will be designed to meet the maximum working pressure of the system.

K. Blind Flanges

1. Blind flanges shall be steel grade ASTM A-181 or ASTM A-105 and mate with the line plugging. Minimum blind flange thickness shall comply with AWWA C-207.

L. Flange Gaskets

1. All gaskets shall be of non-asbestos composition and designed to mate to the inner bore and inner bolt circle of the line plugging flange.

2. All gaskets shall be .125" minimum thickness.

M. Fasteners

1. All external bolting, studs and nuts shall be made of 316 Stainless Steel.

N. Pressure Test Port

1. Each fitting shall be furnished with a factory supplied ¾" threaded test outlet and plug attached to the hot tap and stopple nozzle.

O. Finish

1. After completion of fabrication, all fittings shall be coated both internally and externally in accordance with Specification Section 09900.

2.04 EQUIPMENT

A. General

1. All equipment utilized for the wet tapping and line stop operations shall be designed and manufactured to meet the maximum working pressure of the system onto which they are to be used. All equipment that will come into contact with potable water will be suitably chlorinated at the jobsite, under the supervision of the Resident Project Representative, prior to mounting to the valve used for wet tapping or line stops.

B. Wet Tapping Machinery:

1. Wet tapping machinery shall be designed and constructed to withstand the pressure and mechanical forces to be encountered during the wet tapping process. Equipment shall be power operated. The machinery utilized to

perform each wet tap shall have a pressure tight chamber attached to the power rotation portion of the mechanism. The shell cutter utilized for the trepanning process shall have carbide or high strength carbon steel tips to insure a smooth cut. Shell cutter will be inspected by the Resident Project Representative for sharpness prior to mounting the wet tap machine to the valve.

2. The pilot drill shall have a carbide or high strength carbon steel tip and inspected by the Resident Project Representative. The drill shall be furnished with a "coupon catching" device to insure that every precaution has been taken to recover the cut out pipe section. Resident Project Representative will inspect the coupon catching devise. The use of threaded tip pilot drills that act as coupon catching devices is strictly prohibited. The Contractor shall demonstrate calculations that the catching mechanism is of sufficient strength to retain the weight of the cut out pipe section.

C. Pipe Plugging Equipment:

1. All equipment utilized for the pipe plugging operation shall be designed and manufactured to meet the maximum working pressures of the system.

2. All equipment will be pressure rated for a minimum 150 psig working pressure through 54-inch diameter pipe. The pressure ratings will include a suitable safety factor above the operating pressures in the equipment design calculations.

D. Temporary Pipe Plugging Control Valve:

1. Temporary pipe plugging control valve shall be provided by the wet tapping Contractor along with a certificate of pressure test, at the factory, for the maximum pressures to be encountered while working on the pipe. All valves shall have a minimum bore that permits placement and removal of the factory supplied completion plug.

2. All temporary valves shall be provided and returned upon project completion.

E. Pipe Plugging Machinery:

1. The pipe plugging machinery shall consist of an actuator attached to a pressure tight housing. Contained within the pressure tight housing shall be a plugging head with an elastomeric seal captured between steel plates. The design and operation of the plugging head and sealing element shall meet the maximum pressures to be encountered in the water system. The sealing element shall be manufactured of elastomeric material and be non-

toxic. The use of a vegetable base lubricant shall be mandatory for placement of the sealing element into the pipe system.

2. Pipe plugging equipment shall be provided by the tapping Contractor with a flanged outlet on the plugging head housing. The plugging machine flanged outlet shall permit the Contractor to provide and install a temporary by-pass pipe system between the two plugging machines thus facilitating the maintenance of constant service while the primary pipe system under goes alterations.

F. Purge and Equalization:

1. Pipe plugging requires the use of an ancillary fitting for de-pressurization of the pipe system after the pipe plugging head has been placed into the system. The purge and equalization fitting is used to insure the integrity of the pipe plugging mechanism, to insure no other valves in the system might be open or not holding and to safely depressurize and pump the water out of the main prior to modification. This fitting is also required to introduce pressure into the pipe system after alterations are completed. The pipe system pressure must be equalized on both sides of the plugging head to permit its removal from the system. Wherever possible, existing connections shall be used for this purpose. When existing fittings are not available, then the tapping Contractor will provide a completion type fitting for this purpose.

2.05 FITTING TYPE FOR CARBON STEEL PIPING

A. General Description:

1. The wet tap and line stop fittings to be used for this type work shall be a carbon steel nipple type weld on fitting. The fitting shall be constructed of high strength steel, the nozzle from A-106 grade B material, and the completion flange from A-105 flange material.

PART 3 - EXECUTION

3.01 FITTING INSTALLATION

A. Fitting Field Installation: General

1. Fitting shall be installed in accordance with the manufacturer's recommendation. In no case shall the fitting be retrofitted while it is on the pipe. Any adjustments in fitting installation will require the Contractor to remove the fitting from the pipe and make Engineer and Owner approved alterations.

2. All wet tap and line stop work performed on active water mains shall be done in a sanitary manner to prevent cross connection with non-potable water mains or contamination from groundwater. All materials that may come into contact with water in the pipeline shall be spray disinfected per AWWA standards. If required to perform the work, temporary bypass piping shall be flushed, disinfected, and sampled for bacteriological clearance in accordance with the requirements for new water mains.

B. Suggested Installation Instructions: Cast Iron or Ductile Iron Pipe

1. Pipe Preparation:

The pipe shall be excavated at the location indicated on the plans and specifications. Excavation shall be in accordance with current O.S.H.A safety standards. Excavation shall include necessary sheeting and shoring, gravel base and site de-watering. Proper pipe support and thrust restraint shall be in place prior to the start of wet tap saddle installation. The pipe shall be thoroughly cleaned down to the factory supplied outside diameter. The pipe shall be carefully inspected, especially at the point where the fitting "O" ring must seal to the pipe surface. Any surface pitting shall be filled in with an Engineer approved epoxy or the site moved to an acceptable location.

2. Installation

The bottom half of the fitting shall be placed around the pipe first and properly supported from the bottom of the pipe with wood cribbing. The top half of the fitting shall have the O-ring seal lightly lubricated with vegetable base grease and then place upon top of the pipe. Side seam draw bolts shall be installed and the fitting halves shall be uniformly drawn together, in a loose fashion, starting from the center and working out to each end. The flange will be plumbed using a spirit level. Once the outlet flange is plumb, the sides of the fitting shall drawn together until the O-ring is compressed against the pipe surface. The use of a feeler gauge may be used to determine "O" ring compression.

3. Pressure Testing

A blind flange shall be attached to the fitting flange outlet and a suitable pressure test applied to check the contoured elastomeric O-ring seal. After successful pressure test, the blind flange shall be removed. The field pressure test shall not exceed the internal line pressure.

4. Concrete Encasement and Thrust Restraint

a. After acceptance of the pressure test, concrete support and thrust restraint shall be placed around the fitting and pipe joints to properly support the pipe, including equipment weights, and to prevent lateral movement of the pipe joints when the system is altered downstream of the line stopping process. The size and length of the concrete support shall be based upon the Contractor's calculation and existing site, pressure and soil conditions.

3.02 FIELD PROCEDURES

A. Field Procedures for Wet Taps and Line Stops shall be performed in accordance with the best practices for such work. An example of field procedures for Cast Iron and Ductile Iron Pipe is provided below to establish the level of effort anticipated. A project specific field procedure shall be submitted with the work plan noted in paragraph 1.03, C above.

1. Contractor shall provide a safe work environment in accordance with current OSHA Standards.

2. Contractor shall excavate, expose and clean the outer surface of the main so that the pipe to be tapped or plugged can be measured by a caliper and tape measure prior to manufacture of the required special fitting.

3. The Contractor shall be responsible for proper pipe support and the excavation will be in compliance with current O.S.H.A. safety standards.

4. Pipe plugging fitting drawings shall be prepared and submitted for approval Engineer and Owner prior to manufacture.

5. The Contractor shall properly install the fitting in accordance with the manufacturer's recommendations. After installation, the fitting shall be suitably pressure tested.

6. After fitting installation the Contractor shall provide sufficient concrete support under and around each fitting based upon existing soil conditions, the size and weight of the equipment to be mounted to the fitting, and anticipated lateral thrust that shall be placed on the fittings and pipe sections at the time of the pipe plugging operations and main line alterations. Lateral thrust restraint is required. The Contractor shall also take into consideration the lateral thrust that shall be placed on the pipe and plugging fitting at the time work is to be performed downstream of the line stops. The Contractor shall provide thrust forces on the fitting and equipment based upon operating pressures of the system.

7. Concrete shall reach minimum cure strength as specified by the Engineer prior to the mounting of any tapping-plugging machinery. The use of concrete additives to speed the cure time shall be used with the approval of the Engineer.

8. Upon acceptance of concrete support and thrust cure process, the Contractor shall provide and install the temporary control valve on to the plugging fitting.

9. The wet tap machine shall be field chlorinated and mounted to the temporary control valve. The wet tap will be performed and the cut out pipe section (coupon) will be retracted into the tapping machine's pressure housing. The temporary control valve shall be closed, the tapping machine de-pressurized and removed from the temporary control valve.

10. Wet tap technician shall be required to furnish, to the Resident Project Representative, written calculations for the wet tap and line stop operation. The written calculation shall include pilot drill travel, location of the pilot drill keeper wires in relation to the severed coupon and wet tap shell cutter travel. Wet tap machine shall be provided with a positive travel measurement device and all calculations shall be verified by the Resident Project Representative prior to the start of the tap. Plugging head sealing element sizing data and plugging head travel calculations shall be provided in a written format. Completion plug setting calculations shall also be required.

11. Once the wet tap machine has been attached to the valve, the wet tap pilot drill shall be advanced to the pipe face by hand. Travel calculations will be checked in relation to the previous recorded data. Once the pilot drill has penetrated the pipe wall, the wet tap machine shall be shut down and all joints inspected for leaks. The wet tap process shall be continued to the pre determined cut completion calculation. The machine shall be shut down and the cutting head retracted by hand back to the start measurement.

12. The coupon shall be removed from the wet tap machine and the coupon shall be measured for the purpose of verification of the pipe line stop sealing element.

13. The plugging machine shall be field chlorinated and mounted to the temporary control valve(s).

14. The plugging sealing element(s) shall be lubricated with vegetable base grease only and prior to retraction into the pressure housing. No petroleum base grease is permitted.

15. Installation of Temporary By-Pass Line Applications

    a. Contractor shall connect temporary by-pass line to each flange connection on each stopple machine housing.

    b. The temporary control valve(s) shall be opened and the plugging head(s) will be inserted to the measured and calculated distance into the main line.

16. The downstream plugging head shall be placed into the system first. Once the line plugging head is seated in the main, the system will be de-pressurized downstream of the plugging head using the special purge fitting provided for that purpose, or through existing system connections.

17. De-pressurization shall be in accordance with the below listed fitting sizes based upon the main size being plugged:

    a) Main size 4" to 20" 2"
    b) Main size 22" to 48" 4"
    c) Main size 54" and larger 6" minimum

18. Once de-pressurization is confirmed then the Contractor may perform alterations to the pipe system as specified.

19. Upon termination of pipe alterations, the pipe system shall be re-sealed and pressure will be introduced into the section of the pipe that has been modified.

20. With system pressure equalized on both sides of the plugging head(s), the plugging head(s) shall be removed from the pipe system and retracted back into the pressure housing on the plugging machine(s). The temporary control valve shall be closed and the line plugging machine de-pressurized and removed from the temporary control valve.

21. Removal of Temporary By-Pass Line Applications

    a) After the plugging head(s) are removed from the pipeline and the control valve(s) are closed the Contractor shall drain the temporary by-pass line and remove it from the stopple machine(s).

    b) A completion machine shall have the completion plug mounted to the tool holder and the completion plug O-ring will be lubricated with vegetable based grease. The completion machine will be installed on the temporary control valve and the valve opened.

22. The completion plug shall be lowered to the pre-measured distance into the special flange on the line plugging fitting. The completion plug shall be securely locked into position and verified locked by the hot tap field technician.

23. The completion machine shall be disconnected from the completion plug tool holder, the machine depressurized to confirm the plug is secure and holding. The completion machine shall be removed from the temporary control valve.

24. The temporary control valve will be removed from the plugging fitting and a gasket and blind flange will be installed on the plugging fitting.

END OF SECTION

SECTION 15129

COUPLINGS AND CONNECTORS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: Furnish and install couplings and connectors of the type(s) and size(s) in the location(s) shown on the Drawings and as specified herein. Pipe supports shall be placed where shown on the Drawings. The Contractor may install additional pipe supports and flexible couplings to facilitate piping installation, provided that complete details describing their location, the pipe supports and hydraulic thrust protection are submitted. Thrust protection shall be adequate to sustain the force developed by 150% of the design operating pressures specified.

B. Related Work Described Elsewhere:

1. Mechanical- General Requirements: Section 15000.

2. Pressure Testing of Piping: Section 15044.

C. General Design (Not Applicable)

1.02 QUALITY ASSURANCE

A. Minimum pressure rating equal to that of the pipeline in which they are to be installed.

B. Couplings and connectors, other than those specified herein, are subject to the Engineer's approval.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Submit shop drawings in accordance with the Section 01340 and the following.

2. Submit manufacturer's catalog data on couplings and connectors. Show manufacturer's model or figure number for each type of coupling or joint for each type of pipe material for which couplings are used.

3. Submit manufacturer's recommended torques to which the coupling bolts shall be tightened for the flexible gasketed sleeve-type compression pipe couplings.

4. Show materials of construction by ASTM reference and grade. Show dimensions.

5. Show number, size and material of construction of the rods and lugs for each thrust harness on the project.

B. Additional Information (Not Applicable)

C. Operating Instructions (Not Applicable)

1.04 PRODUCT DELIVERY STORAGE AND HANDLING

A. Equipment shall be handled, shipped and stored in accordance with Section 01600 - Material and Equipment.

1.05 WARRANTY AND GUARANTEES

A. Provide equipment warranty in accordance with Section 01740 - Warranties and Bonds.

PART 2 - PRODUCTS

2.01 GENERAL (Not Applicable)

2.02 MATERIALS AND EQUIPMENT

A. All Couplings and Connectors:

1. Gasket Materials: Composition suitable for exposure to the liquids to be contained within the pipes.

2. Diameters to properly fit the specified types of pipes on which couplings and connectors are to be installed.

B. Sleeve-Type Couplings (when applicable):

1. Exposed couplings (when applicable):

a. Steel middle ring

b. Two steel follower rings

c. Two wedge-section gaskets

d. Sufficient steel bolts to properly compress the gaskets

e. Restrained

f. Acceptable manufacturers

(1) Smith-Blair, Inc. 470 Series Pipe-Lok

(2) Dresser Manufacturing Co.

(3) Romac

2. Buried Couplings (when applicable):

a. Steel middle ring

b. Steel or ductile iron follower rings

c. Two wedge-section gaskets

d. Bolts and nuts for buried couplings, shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8 for bolts, and ASTM A 194, Grade 8 for nuts.

e. Restrained

f. Acceptable manufacturers:

(1) Smith-Blair, Inc. 470 Series Pipe-Lok

(2) Dresser Manufacturing Co.

(3) Romac

C. Flanged Adapters (when applicable):

1. For joining plain end or grooved end pipe to flanged pipes and fittings.

2. Adapters shall conform in size and bolt hole placement to ANSI standards for steel and/or cast iron flanges 125 or 150 pound standard unless otherwise required for connections.

3. Exposed Sleeve Type (Ferrous Piping):

   a. Constructed from steel

   b. Coating: Enamel

   c. Bolts: Carbon steel

   d. Pipe Restraint: Wedge type restraint

   e. Acceptable manufacturers:

      (1) Smith-Blair Inc. – 911 or 920 Series FlangeLok

      (2) Dresser Manufacturing Co.

      (3) Romac

4. Buried Sleeve Type:

   a. Constructed from cast iron

   b. Bolts and nuts for buried sleeves shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8 for bolts, and ASTM A 194, Grade 8 for nuts and washers.

   c. Acceptable manufacturers:

      (1) Dresser Manufacturing Co. - Style 127 locking type for cast iron, ductile iron, asbestos cement and steel pipes with diameters of 3 inches through 12 inches.

      (2) Smith-Blair Inc.

      (3) Romac

D. Deflection Joints:

1. Joints designed to permit a nominal maximum deflection of 15 degrees in all directions from the axis of the adjacent pipe length, will prevent pulling apart, and will remain watertight at any angle of deflection under 15 degrees.

2. Material to be manufactured from a composition material suitable for exposure to the liquid, pressure and temperature to be contained within the pipe.

3. Supplied with control rods as required.

E. Transition Couplings: Transition couplings for connecting different pipes having different outside diameters shall be steel: Dresser Style 62 or 162, Rockwell Series 413, Baker Series 212 or 240.

G. Dismantling Joints

1. Combines flanged coupling adaptor and flanged spigot into one assembly.

2. Longitudinal adjustment is provided by the telescoping action of the spigot inside the flanged coupling adapter. The joint shall accommodate up to 2 inches of longitudinal movement.

3. Materials:

Flanged Adaptor Body and Spigot: Steel– ASTMA53 or A283. Grade C, minimum yield strength of 30,000 psi.
Follower Flange: Steel- ASTMA536, Ductile Iron per ASTMA536, or carbon steel, minimum yield of 30,000 psi.
Gasket: Buna-N

4. Manufacturing Smith Blair, Model 975, Romac DJ 400 Series or Dresser Manufacturing Co.

2.03 ACCESSORIES

A. Joint Harnesses:

1. Tie bolts or studs shall be as shown in the following table. Bolt or stud material shall conform to ASTM B 193, Grade B7. Nuts shall conform to ASTM A 194, Grade 2H. Lug material shall conform to ASTM A 36, ASTM A 283, Grade B, C, or D, or ASTM A 285, Grade C. Lug dimensions shall be as shown in AWWA Manual M11, Table 19.7.

TIE BOLTS OR STUD REQUIREMENTS
FOR FLEXIBLE PIPE COUPLINGS

Tie Bolt or Stud Minimum Requirements

	150 psi		300 psi	
Nominal Pipe Size (Inches)	No. Bolts or Studs	Size (Inches)	No. Bolts or Studs	Size (Inches)
2	2	5/8	2	5/8
3	2	5/8	2	5/8
4	2	5/8	2	4/8
6	2	5/8	2	5/8
8	2	5/8	2	5/8
10	2	5/8	2	5/8
12	2	3/4	2	7/8
14	2	3/4	2	1
16	2	7/8	2	1-1/4
18	2	1	2	1-3/8
20	2	1	2	1-1/2
24	4	1	4	1-1/4
30	4	1-1/8	4	1-1/2
36	4	1-1/4	4	1-3/4
42	4	1-1/2	6	1-5/8
48	6	1-3/8	6	1-7/8
54	6	1-1/2	6	2-1/4
60	6	1-5/8	8	2
66	6	1-3/4	8	2-1/4
72	6	1-7/8	10	2-1/4
84	6	2-1/4	12	2-1/4
96	8	2-1/4	14	2-1/4

2. Select number and size of bolts based on the test pressure shown in Section 15044. For test pressures less than or equal to 150 psi, use the 150-psi design in the table above. For test pressures between 150 and 300 psi, use the 300-psi design in the table above.

3. Provide washer for each lug. Washer material shall be the same as the nuts. Minimum washer thickness shall be 1/8-inch.

B. Bolts and Nuts for Flanges:

1. Bolts and nuts for flanges located indoors and in enclosed vaults and structures shall be carbon steel, ASTM A 307, Grade B.

2. Bolts and nuts for buried and submerged flanges, flanges in open vaults and structures, and flanges located outdoors above ground shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8M for bolts, and ASTM A 194, Grade 8M for nuts.

3. Bolts used in flange insulation kits shall conform to ASTM B 193, Grade B7. Nuts shall comply with ASTM A 194, Grade 2H.

4. Provide washers for each unit. Washers shall be of the same material as the nuts.

2.04 SPARE PARTS (Not Applicable)

2.05 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 PREPARATION (Not Applicable)

3.02 INSTALLATION

A. Sleeve Type Couplings (when applicable):

1. Thoroughly clean pipe ends for a distance of 8 inches from the ends prior to installing couplings, and use soapy water as a gasket lubricant.

2. Slip a follower ring and gasket (in that order) over each pipe and place the middle ring centered over the joint.

3. Insert the other length into the middle ring the proper distance.

4. Press the gaskets and followers evenly and firmly into the middle ring flares.

5. Insert the bolts, finger tighten and progressively tighten diametrically opposite nuts uniformly around the adapter with a torque wrench applying the torque recommended by the manufacturer.

6. Insert and tighten the tapered threaded lock pins.

7. Insert the nuts and bolts for the flange, finger tighten and progressively tighten diametrically opposite bolts uniformly around the flange to the torque recommended by the manufacturer.

B. Split Type Flange Adapters (when applicable): Install in the same manner as Split Type Couplings.

C. Buried Couplings, Adapters and Connectors (when applicable): Thoroughly coat all exterior surfaces, including nuts and bolts, after assembly and inspection by the Engineer with a heavy-bodied bituminous mastic as approved by the Engineer.

D. Install thrust rods, supports, and other provisions to properly support pipe weight and axial equipment loads.

3.03 INSPECTION AND TESTING

A. Hydrostatically test flexible pipe couplings, and joints, in place with the pipe being tested. Test in accordance with Section 15044.

3.04 START-UP AND INSTRUCTION (Not Applicable)

END OF SECTION

SECTION 15140

HVAC AND PLUMBING SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.

2. Trapeze pipe hangers.

3. Metal framing systems.

4. Thermal-hanger shield inserts.

5. Equipment supports.

B. Related Sections:

1. Division 5 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

2. Section 15150 "Vibration Control for HVAC" for vibration isolation devices.

1.03 DEFINITIONS

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

1.04 PERFORMANCE REQUIREMENTS

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

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.05 ACTION SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1.06 INFORMATIONAL SUBMITTALS

A. Welding certificates.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.02 TRAPEZE PIPE HANGERS

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

2.03 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

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

a. B-line, an Eaton business.

b. Flex-Strut Inc.

c. Thomas & Betts Corporation; A Member of the ABB Group.

d. Unistrut; Part of Atkore International.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

3. Standard: MFMA-4.

4. Channels: Continuous slotted steel channel with inturned lips.

5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel (administration area) or stainless steel (process area).

7. Metallic Coating: Hot-dipped galvanized.

2.04 THERMAL-HANGER SHIELD INSERTS

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

1. Carpenter & Paterson, Inc.

2. Clement Support Services.

3. ERICO International Corporation.

4. National Pipe Hanger Corporation.

5. Pipe Shields Inc.

6. Piping Technology & Products, Inc.

7. Rilco Manufacturing Co., Inc.

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

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

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

E. Insert Length: Extend 2 inchesbeyond sheet metal shield for piping operating below ambient air temperature.

2.05 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.06 EQUIPMENT SUPPORTS

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

2.10 MISCELLANEOUS MATERIALS

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

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

1. Properties: Nonstaining, noncorrosive, and nongaseous.

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

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

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

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

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

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

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

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

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

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

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

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

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

L. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4and larger if pipe is installed on rollers.

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

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4 to NPS 12: 12 inches long and 0.06 inch thick.

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

3.02 EQUIPMENT SUPPORTS

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

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

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

3.03 METAL FABRICATIONS

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

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

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

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

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

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

3.05 PAINTING

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

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

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09961.

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

3.06 HANGER AND SUPPORT SCHEDULE

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

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

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

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

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

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

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

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

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24if little or no insulation is required.

4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.

6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

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

9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.

10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.

11. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

12. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

13. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36.if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. C-Clamps (MSS Type 23): For structural shapes.

5. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

6. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

   a. Light (MSS Type 31): 750 lb.

   b. Medium (MSS Type 32): 1500 lb.

   c. Heavy (MSS Type 33): 3000 lb.

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

8. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

9. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

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

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

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

END OF SECTION

SECTION 15150

VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Open-spring isolators.
4. Elastomeric hangers.
5. Spring hangers.
6. Vibration isolation equipment bases.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

1.04 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.01 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

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

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. Vibration Isolation.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.

3. Size: Factory or field cut to match requirements of supported equipment.

4. Pad Material: Oil and water resistant with elastomeric properties.

5. Surface Pattern: Waffle pattern.

2.02 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

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

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. Vibration Isolation.

2. Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts].

b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.03 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

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

   a. Kinetics Noise Control, Inc.

   b. Mason Industries, Inc.

   c. Vibration Eliminator Co., Inc.

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.

3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.04 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

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

   a. Kinetics Noise Control, Inc.

   b. Mason Industries, Inc.

   c. Vibration Isolation.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 150 percent of rated load, fully compressed, without deformation or failure.

7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.02 VIBRATION CONTROL DEVICE INSTALLATION

A. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION

SECTION 15190

HVAC AND PLUMBING PIPING AND EQUIPMENT IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Equipment labels.

2. Warning signs and labels.

3. Pipe labels.

4. Duct labels.

5. Valve tags.

6. Warning tags.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

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

D. Valve numbering scheme.

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

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Letter Color: White.

3. Background Color: Black.

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

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

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

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

B. Plastic Labels for Equipment:

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

2. Letter Color: White.

3. Background Color: Black.

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

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

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

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

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

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

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

2.02 WARNING SIGNS AND LABELS

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

B. Letter Color: Black.

C. Background Color: Yellow.

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

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

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

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

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

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

2.03 PIPE LABELS

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

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

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

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.04 DUCT LABELS

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

B. Letter Color: White.

C. Background Color: Refer to Installation article below.

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

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

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

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

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

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.05 VALVE TAGS

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

1. Tag Material: Brass, 0.032-inch (0.8-mm) or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link chain or beaded chain.

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

1. Valve-tag schedule shall be included in operation and maintenance data.

2.06 WARNING TAGS

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

1. Size: 3 by 5-1/4 inches minimum.

2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Safety-yellow background with black lettering.

PART 3 - EXECUTION

3.01 PREPARATION

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

3.02 GENERAL INSTALLATION REQUIREMENTS

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

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

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

3.03 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.04 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in Section 09961.

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

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of [50 feet] <Insert dimension> along each run. Reduce intervals to [25 feet] <Insert dimension> in areas of congested piping and equipment.

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

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:

1. Refrigerant Piping: Black letters on a safety-purple background

2. Condensate Piping: White letters on a safety-gray background

3. Domestic Water Piping: White letters on a safety-green background

4. Sanitary Waste and Storm Drainage Piping: Black letters on a safety-gray background

5. Low-Pressure Compressed Air Piping: White letters on a safety-blue background

6. High-Pressure Compressed Air Piping: White letters on a safety-blue background

3.05 DUCT LABEL INSTALLATION

A. Install [plastic-laminated] [self-adhesive] duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.

2. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.06 VALVE-TAG INSTALLATION

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

1. Valve-Tag Colors:

a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.

b. Flammable Fluids: Black letters on a safety-yellow background.

c. Potable and Other Water: White letters on a safety-green background.

d. Compressed Air: White letters on a safety-blue background.

e. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

3.07 WARNING-TAG INSTALLATION

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

END OF SECTION

SECTION 15256

HVAC AND PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.

2. Refrigerant suction and hot-gas piping, indoors and outdoors.

3. Domestic cold-water piping.

4. Domestic hot-water piping.

5. Supplies and drains for handicap-accessible lavatories and sinks.

B. Related Sections:

1. Section 15258 "Duct Insulation."

1.03 ACTION SUBMITTALS

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

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

1.05 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 15140.

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

1.08 SCHEDULING

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

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

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

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

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

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

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

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

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.

2. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

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

a. Aeroflex USA, Inc.

b. Armacell LLC.

c. K-Flex USA.

2.02 ADHESIVES

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

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

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

    a. Dow Corning Corporation.

    b. Johns Manville; a Berkshire Hathaway company.

    c. P.I.C. Plastics, Inc.

2.03 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).

3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.

2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).

3. Solids Content: 60 percent by volume and 66 percent by weight.

4. Color: White.

2.04 SEALANTS

A. Cellular-Glass, Phenolic, and Polyisocyanurate Joint Sealants:

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Fire- and water-resistant, flexible, elastomeric sealant.

3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

4. Color: Aluminum.

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

1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Fire- and water-resistant, flexible, elastomeric sealant.

3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

4. Color: White.

2.05 FACTORY-APPLIED JACKETS

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

1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.06 FIELD-APPLIED JACKETS

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

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

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

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

a. Johns Manville; a Berkshire Hathaway company.

b. P.I.C. Plastics, Inc.

c. Proto Corporation.

3. Adhesive: As recommended by jacket material manufacturer.

4. Color: White.

5. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

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

C. Metal Jacket:

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

a. ITW Insulation Systems; Illinois Tool Works, Inc.

b. RPR Products, Inc.

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

a. Sheet and roll stock ready for shop or field sizing.

b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

d. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.

2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.

3) Tee covers.

4) Flange and union covers.

5) End caps.

6) Beveled collars.

7) Valve covers.

8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

2.07 TAPES

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

1. Width: 3 inches (75 mm).

2. Thickness: 11.5 mils (0.29 mm).

3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.

4. Elongation: 2 percent.

5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.

6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

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

1. Width: 2 inches (50 mm).

2. Thickness: 6 mils (0.15 mm).

3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.

4. Elongation: 500 percent.

5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

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

1. Width: 2 inches (50 mm).

2. Thickness: 3.7 mils (0.093 mm).

3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.

4. Elongation: 5 percent.

5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.08 SECUREMENTS

A. Bands:

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

2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

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

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

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

3.02 PREPARATION

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

3.03 GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

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

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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

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

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

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

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 PENETRATIONS

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

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

4. Seal jacket to wall flashing with flashing sealant.

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

D. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

3.05 GENERAL PIPE INSULATION INSTALLATION

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

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

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

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

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

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

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

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in

two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

3.07 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.08 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturers recommended adhesive.

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

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

3.09 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

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

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

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

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

3.11 PIPING INSULATION SCHEDULE, GENERAL

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

3.12 PIPING INSULATION SCHEDULE

A. Interior Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.

b. Flexible Elastomeric: 1 inch thick.

B. Interior Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.

b. Flexible Elastomeric: 1 inch thick.

C. Exterior Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 2 inches thick.

b. Flexible Elastomeric: 2 inch thick.

D. Interior Domestic Cold Water:

1. NPS 1 and smaller: Insulation shall be one of the following:

a. Flexible Elastomeric: 1/2 inch thick.

2. NPS 1-1/4 to 2-1/2: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.

3. NPS 3 and larger: Insulation shall be one of the following:

a. Flexible Elastomeric: 1-1/2 inch thick.

E. Domestic Hot and Recirculated Hot Water:

1. All piping sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.

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

3. All piping sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1/2 inch thick.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. General Service – PVC, 30 mils thick.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Piping, Concealed:

1. Stainless Steel, Type 316, Smooth 2B Finish, 0.016 inch thick.

D. Piping, Exposed:

1. Stainless Steel, Type 316, Smooth 2B Finish, 0.016 inch thick.

END OF SECTION

SECTION 15258

DUCTWORK INSULATION

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Work of this section shall include providing the thermal insulation for mechanical systems and shall include the following principal items:

1. Supply, Return, Outside, and Relief Air ductwork concealed.

2. Supply, Return, Outside, and Relief Air ductwork exposed.

3. Exhaust Air ductwork concealed.

4. Exhaust Air ductwork exposed.

B. Not all of the insulation types specified herein may be required on this project. The contractor is only to provide those insulation types required for the applications on this project.

C. This work shall be performed by a competent insulation contractor regularly engaged in the scope of work described herein.

1.02 SUBMITTALS

A. Submittals and product literature for each insulation type, finish type, and equipment served. Provide submittals on method of installation for each type of insulation used.

PART 2 - PRODUCTS

2.01 THERMAL INSULATION

A. All insulating systems shall be tested on a composite basis in accordance with NFPA and UL 723 and shall have a maximum flame spread rating of 25 and a maximum smoke developed rating of 50 under ASTM E-84.

B. Insulation Types:

1. FIBERGLASS BLANKET

Made of flame - attenuated glass fibers, bonded with a thermosetting resin. Reinforced with fiberglass scrim facing laminated to UL rated kraft. FSK facing, .02 perms, .00035" foil thickness per ASTM E-96, procedure A. 2" thick, 0.75 PCF, 7.1 R value. Equal to Manville, MicroLite.

2. RIGID FIBERGLASS

3 lb. density, .23 k factor. Mil spec HH-1-558B.. Inorganic glass fibers bonded by a thermosetting resin with an FSK jacket in compliance with NFPA 90A AND 90B standards. Equal to Manville 814, 3 lb density, R-8.7, 2" thick with FSK jacket.

3. FIBERGLASS BLANKET

Made of flame - attenuated glass fibers, bonded with a thermosetting resin. Reinforced with fiberglass scrim facing laminated to UL rated kraft. FSK facing, .02 perms, .00035" foil thickness per ASTM E-96, procedure A. 3" thick, 3/4 lb., 10.7 R value. Equal to Manville, Microlite.

4. SEMI RIGID FIBERGLASS BOARD

3lb. density, thermal conductivity compliance ASTM C 518, 650 degrees F temperature limit, 1 1/2" thick. High temperature fiberglass bonded to a flexible jacketing. Jacketing is a laminate of white kraft and aluminum foil, reinforced with fiberglass, chemically treated for fire and smoke safety. Equal to Manville Pipe and Tank Insulation.

5. DUCT LINER

Acoustical and thermal insulation manufactured from long textile, type glass fibers firmly bonded together with a thermosetting resin. Air stream surface is coated to protect against air erosion. Up to 250 degrees F (ASTM C 411), NFPA 90A and 90B, ASTM C 1071: not greater than 0.5% moisture by volume at 120 degrees F and 96% RH. Equal to Certainteed 1" thick, type 150, .28 K value for up to 2,500 FPM velocity.

D. Duct Tape

1. FSK, glass fiber impregnated with foil facing, 4"wide, M.L spec HHB100, 25/50, ASTM E-84.

E. Adhesives

1. Water based adhesives for attaching low density fibrous insulation and duct liner to metal. Service temperature limits-20 degrees F to 250 degrees F, UL MJAT-2, ASTM C 916, type 11, NFDA 90A and 90B. Equal to Foster Quick Tack Adhesive 85-60.

PART 3 - EXECUTION

3.01 WORKMANSHIP

A. All materials shall be applied by Workmen skilled in this trade. Unsightly work shall be cause for rejection.

B. Mechanical fasteners shall be used whenever possible to assure permanent construction.

C. Materials shall be applied only after systems have been tested and all surfaces are clean and dry.

E. All insulation of cold surfaces shall be vapor sealed. All joints, laps, breaks and faults in vapor barriers of insulations covering cold surfaces shall be thoroughly sealed.

F. Insulation that becomes wet for any reason shall be removed, replaced and resealed at the expense of this Contractor.

3.02 APPLICATION

A. Interior, Concealed Square or Round Ductwork

Use FIBERGLASS BLANKET as per Part 2, 2.01, B-1. For square ducts with any one dimension not greater than 24". Insulation shall be wrapped around ducts and secured with outward clinching staples at 4 inches o.c.. Ducts 24 inches and greater shall have insulation additionally secured with stick clips on 18 inch centers or with 4 inch wide bands of adhesive applied on 18 inch centers. Insulation shall be lapped a minimum of 4" and all seams and penetrations shall be sealed with FSK Duct tape as per Part 2, 2.01, D-1.

B. Rectangle, Interior Supply, Return, Outside Relief and Exhaust Air Ductwork, Exposed.

Use FIBERGLASS BOARD insulation as per Part 2, 2.01, B-2, and shall be applied to ducts with mechanical fasteners such as stick cups or weld pins at 12 inch centers.

Install fiberglass board in full pieces. Joints and seams shall be covered with 4" tape as per Part 2, 2.01, D-1. Where standing seams or angle supports exceed insulation thickness an additional layer of board will be used.

C. Round, Interior Supply, Return, Outside , Exhaust and Relief Ductwork Exposed.

Round ductwork use SEMI RIGID FIBERGLASS BOARD as per Part 2, 2.01, B-4. Flexible fiberboard shall be applied to ducts with outward clinching staples. Make any fabrication cuts to accommodate the proper fitting of the insulation before stapling. In addition any square ducts with a width of 24" or greater shall employ the use of stick clips spaced at 12" o.c.. Joints, seams and any penetrations shall be sealed with matching tape.

D. Exterior, Exposed Ductwork

Use RIGID FIBERGLASS BOARD as per Part 2, 2.01, B-2. Apply board with mechanical fasteners such as stick clips or weld pins with retainers spaced as required to assure contact between insulation and metal. Finish insulation with two coats of INSULKOTE ET (Part 2, 2.01, C-1) with an intermediate layer of glass fabric equal to Mast-a-Fab. Prime all insulation with Insulkote Primer E or equal for a fully weatherproof system.

3.03 MISCELLANEOUS

A. Ductwork indicated on the drawings to be internally lined shall not be insulated externally.

B. All insulating systems described herein shall conform to the latest edition of SMACNA and will comply with NFPA-90A, 90B, 30; TIMA AHC-101; ASTM C390, C167, C553, E84, C177, C423, C411, C916, D903, D93, D1151; ASHRAE; ACGIH; Tested for UL 181; Mil Spec A 3316B

C. The engineer will reserve the right to accept or reject any and all work not in compliance with the aforementioned. The engineer will be contacted for inspection during any of the following operations:

1. During installation of any ductwork wrapping.

2. During the installation of ductwork that has been lined.

- END OF SECTION -

SECTION 15400

PLUMBING SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The following described work, materials and equipment shall be furnished and installed as shown on the Drawings and as herein specified.

1. All plumbing fixtures, accessories and trims as shown on the Drawings and as herein specified.

2. Domestic water service, specialties and piping to all fixtures and equipment.

3. All sanitary sewer piping and equipment shown throughout the building and extension of the sanitary sewer to the city sewer.

1.02 RELATED WORK

A. Section 15140 – HVAC and Plumbing Supports and Anchors
B. Section 15256 – HVAC and Plumbing Piping Insulation
C. Section 15410 – Plumbing System Valves

1.03 REFERENCES

A. All plumbing installation and fabrication shall be in accordance with applicable State and Local Plumbing Codes.

1.04 SUBMITTALS

A. Submit catalog data and shop drawings for all materials and equipment listed under this section and per basic mechanical requirements. Include submittal data on related specifications also.

B. Materials, fixtures, or equipment installed without review or after rejection shall be replaced by this contractor with acceptable items at the Engineer's direction.

C. All materials, equipment, and appliances shall be new, without defect, first line quality unless specifically noted or specified otherwise.

D. The supplier, by submitting, certifies the materials and equipment to be satisfactory for the application involved.

E. Submit line drawings for review on all piping and equipment to be installed.

F. Contractor further agrees that if deviations, discrepancies or conflicts between submittals and specifications are discovered either prior to or after submittals are processed by the engineer, the design drawings and specifications shall control and be followed.

1.05 SERVICE AND UTILITY CONNECTIONS

A. Sanitary waste and drainage systems shall terminate at points 5-ft-0-in outside the building or as otherwise shown on the Drawings.

B. Storm water systems serving the rainwater leaders will originate at Roof Drains and terminate at points 5-ft-0-in outside the building or as otherwise shown on the Drawings.

C. The source of water for potable use in the building will be brought to the building under another Division of the work and left as a flanged connection at point 5-ft-0-in outside the building or as otherwise shown on the Drawings.

D. The backflow preventer unit shall be furnished and installed complete with all components as shown on Water Riser Diagrams. The water connections shall be made to these units as shown and from these points furnish and install all water to the building, equipment, fixtures and apparatus, as shown on the Drawings.

PART 2 - PRODUCTS

2.01 PLUMBING FIXTURES

A. General: Provide all plumbing fixtures complete with trim required, and connect in a manner conforming to the local Building Code. Certain fixtures may be furnished by others under other sections of these Specifications. Provide rough-in and final connections including all valves, traps, specialties, etc. required.

B. Provide traps for all waste connections where not furnished with the equipment and stop cocks or valved shut-offs for all water connections to all sinks and other items of equipment. All exposed pipe and metal, including that within cabinets, shall be chrome plated.

C. Faucets, trim, eyewashes and emergency showers furnished to Division 15 contractor by Division 11 contractor for installation by Division 15 contractor

D. Fixture Schedule:

1. P1 – Water Closet: Floor Mounted Back Outlet, Top Spud, Accessible.

a. Manufacturers: American Standard America or equal.

b. Bowl:

Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
Material: Vitreous china.
Type: Siphon jet.
Style: Flushometer valve.
Height: Standard.
Rim Contour: Elongated.
Water Consumption: 1.28 gal per flush.
Spud Size and Location: NPS 1-1/2; top.
Color: White
Flushometer Valve: See Schedule

c. Toilet Seat:

Seat shall be white solid plastic, extended back, open front and less cover with check hinge as manufactured by Church; Bemis or equal

d. Support:

J.R. Smith Co.; Zurn Industries, Inc or equal.

e. Water-Closet Mounting Height:

Handicapped/elderly according to ICC/ANSI A117.1.

2. P2 – Lavatory, Wall Mounted, Rectangular, Accessible:

a. Manufacturers: American Standard America or equal.

b. Fixture:

Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
Material: Vitreous china.
Type: Wall hanging
Nominal Size: 20 by 18 inches
Color: White
Mounting Material: Sealant.
Mounting Height: Handicapped/elderly according to ICC A117.1

c. Support:

Concealed-arm Lavatory carrier by J.R. Smith Co.; Zurn Industries, Inc.; Josam Manufacturing Co. or equal

d. Faucet: See Schedule

Provide angle valves with loose key, escutcheons for supplies, 17 gauge P-trap with cleanout and deep box escutcheon for waste, all shall have a chrome plated finish as manufactured by Engineered Brass Company (EBS) or McGuire Mfg. Co. Insulate supplies and waste per specification 15256.

2.02 DOMESTIC WATER PIPING SYSTEM

A. Under-building-slab:

1. Copper Pipe, 3" and smaller: Type K hard drawn copper per ASTM B-88. Fittings: Wrought copper or cast brass. Joints: Lead free, tin-silver solder.

2. Joints: Shall be push on or mechanical type as indicated on drawings.

C. Above Grade:

1. Copper Pipe: Type L hard drawn copper per ASTM B-88. Fittings: Wrought copper or cast brass. Joints: Lead-free, tin-silver solder.

Note: Mechanically formed TEE connections will be allowed on hard drawn copper only. Joints must be brazed in accordance with the copper development association copper tube handbook using B-cup series filler metal, and manufacturing recommendations.

2.03 DOMESTIC WATER SPECIALTIES

A. Water Hammer Arrestors (WHA):

1. Standard: Meets ASSE 1010 and sized in accordance with PDI WH-201
2. Type: Copper tube with piston
3. Size: ASSE 1010, AA and A through F, or PDI-WH 201, Sizes A through F.
4. Arrestors shall be precharged suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psig working pressure;
5. Model Z-1700 manufactured by Zurn; Josam, Wade or equal.

B. Trap Primers: ANSI/ASSE 1018; bronze body, integral vacuum breaker, replaceable valve seat, bronze access cover with gasket;

2.04 VALVES

A. General:

1. Valves, in general shall be of the same manufacture throughout unless noted otherwise and shall be the approved equal of those as manufactured by Fairbanks Co., Hammond Co., or Jenkins Bros. All valves except as noted otherwise shall be made for 125 pounds steam working pressure and shall have round iron wheel handles.

2. It is the intention of these Specifications to have control valves at bottom of all potable and protected hot and cold water service risers and as noted on the Drawings.

3. Hose End Valves (HEV) shall be installed on house side of main control valves, at bottom of all risers, at all low points, and where noted on the Drawings. These drawoffs shall consist of a gate valve described below. Drawoff valves shall be fitted with hexagon hose nipples and Jenkins No. 658 or Fairbanks Fig. 025 cap and chain or approved equal.

B. Water Valves:

1. All protected and potable water valves 3 inches and smaller unless noted otherwise, shall be brass body gate or ball type and shall be by Fairbanks, Jenkins, or Hammond except adjacent to pumps and tanks where they shall be flanged pattern similar to Fairbank.

2. All water valves, 4 inches and larger, shall be iron body gates, bronze trim, flanged ends, O.S. & Y. pattern, solid wedge, rising spindle, Fairbanks, Jenkin, or Hammon.

3. All check valves 3 inches and smaller shall be similar to Hammond, Fairbanks, or Jenkins. Check valves 4 inches and larger shall be flanged and similar to Fairbank, Hammond or Jenkins.

2.05 SANITARY SEWER AND STORM DRAINAGE PIPING SYSTEM

Note: This contractor shall provide/install cast iron pipe at all fire rated assemblies and return air plenums. This contractor shall coordinate with architectural and mechanical drawings.

A. Buried, Exterior:

1. Cast Iron Pipe: ASTM A-74 spun service weight. Fittings: Cast iron. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C-564

neoprene gaskets.

2. PVC Pipe: Schedule 40 per ASTM D-1785. Fittings: PVC per ASTM D-2466. Joints: Solvent weld per ASTM D-2855 with solvent per ASTM D-2564.

B. Buried, Below Slab:

1. Cast Iron Pipe: ASTM A-74 spun service weight. Fittings: Cast iron. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C-564 neoprene gaskets.

3. PVC Pipe: Schedule 40 per ASTM D-1785. Fittings: PVC per ASTM D-2466. Joints: Solvent weld per ASTM D-2855 with solvent per ASTM D-2564.

C. Buried, Encased in Slab:

1. Cast Iron Pipe: ASTM A-74 spun service weight. Fittings: Cast iron. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C-564 neoprene gaskets.

D. Above Grade:

1. Cast Iron Pipe: ASTM A-74, spun service weight. Fittings: Cast iron. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C-564 neoprene gaskets.

2. Cast Iron Pipe: CISPI 301, hubless, spun service weight. Fittings: Cast iron. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

3. PVC Pipe: Schedule 40 per ASTM D-1785. Fittings: PVC per ASTM D-2466. Joints: Solvent weld per ASTM D-2855 with solvent per ASTM D-2564.

2.06 SANITARY SEWER SPECIALTIES

A. Cleanouts: Provide cleanouts as specified herein, as required to comply with applicable Codes and as indicated on the Drawings. Cleanouts in floors shall be cast iron, push-on type with neoprene gaskets, threaded, adjustable height heads and bronze plugs unless noted otherwise. Cleanouts shall be the same nominal size as the pipe served up to 4" and not less than 4" for line sizes greater than 4". Zurn cleanouts have been specified, however, cleanouts of equal quality as manufactured by Josam, Wade, or J. R. Smith will be acceptable.

1. Cleanouts in unfinished floors shall have round, scoriated, heavy duty, nickel bronze tops; Zurn No. Z-1400-HD.

2. Cleanouts in walls for cast iron piping shall be cast iron ferrules with no-hub joints, cadmium plated cast iron counter sunk plugs and round stainless steel access cover with securing screw; Zurn No. Z-1440.

3. Cleanouts in walls shall have cast iron countersunk plugs and round stainless steel access cover with securing screw; Zurn No. Z-1441.

4. Exterior cleanouts in traffic areas Zurn No. 1400-HD.

B. Floor Drains: Provide floor drains as specified herein and as indicated on the Drawings. Floor drains shall be cast iron, push-on type with neoprene gaskets unless noted otherwise. Zurn floor drains have been specified, however, floor drains of equal quality as manufactured by Josam, Wade or J. R. Smith will be acceptable.

2.07 SANITARY SEWER SYSTEM INSULATION

A. All sanitary piping exposed shall be insulated. Exposed floor drain bodies and P-traps shall be insulated.

C. Insulation shall be 1" thick, jacketed fiberglass. See Section 15250 for additional information.

PART 3 - EXECUTION

3.01 GENERAL

A. Obtain exact centerline rough-in dimensions between partitions or walls from the Architectural Drawings. Work shall be roughed-in so that all exposed piping will be straight and true without bends or off-sets. Water supplies shall connect through walls with stops and chrome plated escutcheons with set screws. Where fixtures are without supporting legs or carriers secure wall hangers to bolts welded to 3/16" steel plates, mounted against walls within chases.

B. Where backs of fixtures join wainscotting or tile, they shall be ground flat and the joints made close. Run bead of white caulking compound around back of fixture at outside edge before final setting. When fixture is set, wipe compound so that joint is sealed. Remove excess compound with solvent. Caulking compound shall be Porter "Brilliant White", Pittsburgh Glass, Sherwin-Williams, or equal.

C. All rough-in sanitary sewer piping shall be properly plugged or capped in a manner approved by the Engineer.

D. Mount fixtures to the following heights above finished floor, unless noted otherwise on the architectural drawings.

Water Closet:

Handicapped	18 inches to rim of bowl

Lavatory:

Handicapped	34 inches to rim of bowl and 27" minimum knee clearance

E. Provide trap primers for all floor drains, floor sinks and open receptacle traps. All trap primers shall be accessible for inspection and/or replacement, provide access panels as required. Coordinate open receptacles with HVAC contractor.

F. Insulate exposed supplies, waste, and P-trap on all lavatories per Specification 15264.

G. Provide copper-plated bracket with holes as required to hold all supplies at all fixtures, brackets similar to Holdrite or approved equal.

3.02 DOMESTIC WATER PIPING SYSTEM

A. Provide a complete system of domestic water piping including interior and exterior work as indicated.

B. Piping shall be accurately cut to measurements established at the project site, worked into place without springing or forcing, run as directly as possible, run parallel or perpendicular to building lines, located as indicated on the Drawings and supported as specified elsewhere. Parallel piping shall be grouped together as much as practical. Piping shall be supported as high as practical. Piping not located in mechanical rooms shall be concealed unless noted otherwise.

C. Piping shall be run as directly as possible, avoiding all unnecessary fittings and joints. Changes in routing of piping due to field conditions shall be at the expense of this Contractor.

D. Contractor shall provide for expansion and contraction of piping systems. Expansion and contraction of piping shall not impart excess stress or strain on the building, pipe fittings, joints or connections to equipment.

E. Piping shall be installed with sufficient spacing between fittings, valves, flanges, etc. so as to allow insulation fittings to be installed without trimming or modification.

F. Provide sleeves for all piping penetrations of grade beams, floors above grade and walls. Sleeves for insulation piping above grade shall be sized for the insulation diameter. Sleeves for piping through walls below grade shall be sized for use of compressible rubber link seals unless noted otherwise.

G. Piping thru slabs on grade shall be protected with 1/2" thick closed cell flexible foam insulation minimum 6 inches above and below slab. Wrap or coat all pipe layed in gravel or in contact with concrete.

H. Provide escutcheon plates at each exposed piping penetration of walls and ceilings. Escutcheon plates for insulated piping shall be sized for the insulation diameter.

I. All piping shall be installed to allow complete draining, slope as required. Provide drain valves at all low points where fixtures cannot be used to drain piping. Provide hose bibb with 3/4" hose connection and vacuum breaker/backflow preventer at water main entrance.

J. Provide shutoff valves at each branch from main. Provide shutoff valves for each fixture group to minimize interruption of service for maintenance and repair. Provide an exterior main shutoff valve and valve box as indicated on drawings.

K. Piping thru metal studs shall be isolated from metal to metal contact with plastic bushings specifically designed for the application.

L. Provide water hammer arrestors for each fixture group as indicated. Capacity of each water hammer arrestor shall meet or exceed the total fixture units of each fixture group. All water hammer arrestors shall be accessible for inspection and/or replacement, provide access panels as required.

M. All stubouts and exposed piping shall be rigidly supported to eliminate movement.

N. This Contractor shall complete all equipment connections to the domestic water piping system. Provide shutoff valves and unions for each connection.

O. Connections to water heaters and connections between ferrous and copper pipe shall be made with dielectric unions or flanges. Joints between plastic and metallic pipe shall be made with transition fittings for the specified purpose.

P. Exterior water line shall have a minimum of 24" cover.

3.04 SANITARY SEWER PIPING SYSTEM

A. Provide a complete system of sanitary sewer drain, waste and vent piping including interior and exterior work as indicated.

B. Piping 6" and smaller shall be sloped at least 1/8 inch per foot. Piping buried below

slab shall be sloped a minimum of 1/8" inch per foot. Piping 8" and larger shall be sloped at least 1/16 inch per foot.

C. Buried piping below slab and exterior of building perimeter shall be laid in minimum 4 inches of bedding below and 6" above pipe, and sloped as specified herein. Bedding shall be accurately and uniformly graded. Bedding shall be crushed stone equal to Alabama Highway Department #9 crushed stone. Bedding shall be free of organic material. Backfill below floor slabs shall be No. 57 crushed stone full depth from top of bedding to bottom of slab.

D. Provide cleanouts as required by Code and as indicated on the Drawings. Cleanouts for piping 4" and smaller shall be line size. Cleanouts for piping 6" and larger shall be 4". Provide dual exterior cleanouts within 5 feet of building. Interior cleanouts in floors shall be flush with finished floors. Interior cleanouts in walls shall be above the flood level of plumbing fixtures. Exterior cleanouts in unpaved areas and areas paved with other than concrete shall be set flush in 15" x 15" x 6" concrete pads flush with finished grade.

E. Vents through roof shall be a minimum of 3 inches in diameter and shall terminate at least 12 inches above the roof. See plans for other sizes.

F. This Contractor shall be responsible for locating vents at least 10 feet from Outside Air intakes, offset vents as required.

G. Drainage piping shall be installed with hubs upstream of each pipe section. Provide reducing fittings where different sizes of pipe are to be connected, bushings shall not be used. Provide longsweep fittings, sanitary tees and combination wyes with 1/8 bends as applicable.

H. All rough-in soil, waste, vent and storm piping shall be properly plugged or capped in a manner approved by the Engineer.

3.05 TESTING

A. All piping shall be tested before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory.

B. Water piping systems shall be subjected to a hydrostatic test of one hundred twenty five pounds minimum or 1 1/2 times operating pressure, whichever is greater. The system shall be proven tight after a twenty-four (24) hour test.

C. All soil waste and vent piping shall be subjected to a hydrostatic test of not less than a 10-foot head or an air test of not less than 5 pounds per square inch using a mercury column gauge. Piping shall be tested for not less than 4 hours, prior to installing

fixtures. Underground piping shall be tested before backfilling.

D. After fixtures have been installed, the entire plumbing system, exclusive of the house sewer shall be subjected to an air pressure test equal to one inch water column and proven tight. The Contractor shall furnish and install all of the test tees required, including those for isolating any portion of the system for tests.

E. Provide test report in booklet form showing all field tests performed to prove compliance with the specified performance criteria. Booklet shall be submitted prior to submitting for final payment. Booklet shall include the following

a. SYSTEM TESTED
b. Date of test
c. Test medium
d. Persons present
e. Pressure tested
f. Lines tested
g. Length of time test pressure was held
h. Pressure drop
i. Water pressure at most remote and highest location
j. residual chlorine

F. This Contractor shall conduct all specified tests until approved by the Engineer. All tests shall be repeated until approved by the Engineer. Piping systems shall not be covered or otherwise concealed until tests inspections have been made and approvals obtained. This Contractor shall notify the Engineer four days prior to testing to allow for scheduling.

G. All reduced Pressure Backflow Preventers (RPBP) and Double Check Backflow Preventers (DCBP) shall be tested by City Utilities or someone certified to test such devices and certificate shall be submitted indicating devices that passed tests.

3.06 STERILIZATION OF DOMESTIC WATER PIPING SYSTEM

A. Thoroughly flush for a minimum of two hours and then drain the domestic water piping prior to sterilizing by the following method or other methods satisfactory to the Engineer and the Authority Having Jurisdiction.

B. The Engineer reserves the right to test the water again at any time prior to final acceptance of the work and if found to be unsafe bacteriologically, to require the Contractor to rechlorinate the system until the water is proven equal to that supplied by the public system.

C. Contractor shall arrange for laboratory testing for a bacteriological examination of potable water system at various locations. The samples shall be tested to meet

requirement of city and shall not be of less quality than provided by city. Submit copy from testing agency prior to submitting for final payment.

D. Minor work such as repairs or replacement of single fitting or valve, pre-clean and disinfect by immersion in solution of 300 ppm chlorine for 1 hour.

3.07 CLEANING

A. At completion of all work, fixtures, exposed materials and equipment shall be thoroughly cleaned.

B. All strainer screens, shall be removed and cleaned.

3.08 FINAL ACCEPTANCE

Before final acceptance, the Plumbing Contractor shall furnish a certificate of inspection and final approval from the plumbing Inspector to the Owner and be in accordance with the latest revisions of the applicable codes and the Approved Plumbing Drawings and Specifications. Contractor shall also furnish booklet of test, sterilization compliance and backflow devices certificates.

END OF SECTION

SECTION 15502

CONDENSATE PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Copper tube and fittings.
2. Joining materials.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pipe.
2. Fittings.
3. Joining materials.

1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Condensate-Drain Piping: 150 deg F (66 deg C).

2.02 COPPER TUBE AND FITTINGS

A. DWV Copper Tubing: ASTM B 306, Type DWV.

B. Copper or Bronze Pressure-Seal Fittings:

1. Housing: Copper.
2. O-Rings and Pipe Stops: EPDM.
3. Tools: Manufacturer's special tools.
4. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F (121 deg C).

C. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube.

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

2.03 JOINING MATERIALS

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

B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

3.02 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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

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

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

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

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

H. Install piping to allow application of insulation.

I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

J. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

K. Comply with requirements in Section 15190.

L. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 15093.

M. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 15093.

N. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 15098.

3.03 DIELECTRIC FITTING INSTALLATION

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

3.04 HANGERS AND SUPPORTS

A. Comply with requirements in Section 15140 for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Spring hangers to support vertical runs.
4. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4:Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

D. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.05 PIPE JOINT CONSTRUCTION

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

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

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

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

E. 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.

F. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

END OF SECTION

SECTION 15504

REFRIGERANT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.
2. Refrigerant piping valves and specialties.
3. Refrigerants.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and piping specialty.

1. Include pressure drop, based on manufacturer's test data, for the following:

a. Thermostatic expansion valves.

b. Solenoid valves.

c. Hot-gas bypass valves.

d. Filter dryers.

e. Strainers.

f. Pressure-regulating valves.

B. Shop Drawings:

1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.

2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

3. Show interface and spatial relationships between piping and equipment.

4. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.07 PRODUCT STORAGE AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.

2. Suction Lines for Heat-Pump Applications: 535 psig.

3. Hot-Gas and Liquid Lines: 535 psig.

2.02 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K.

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

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

D. Brazing Filler Metals: AWS A5.8/A5.8M.

E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.

2. End Connections: Socket ends.

3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.

4. Working Pressure Rating: Factory test at minimum 500 psig.

5. Maximum Operating Temperature: 250 deg F.

2.03 VALVES AND SPECIALTIES

A. Service Valves:

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

a. Danfoss Inc.
b. Emerson Climate Technologies.
c. Parker Hannifin Corp.

2. Body: Forged brass with brass cap including key end to remove core.

3. Core: Removable ball-type check valve with stainless-steel spring.

4. Seat: Polytetrafluoroethylene.

5. End Connections: Copper spring.

6. Working Pressure Rating: 500 psig.

2.04 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

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

a. Arkema Inc.
b. DuPont Fluorochemicals Div.
c. Genetron Refrigerants; Honeywell International Inc.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid, and Suction Lines for Heat-Pump Applications: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.02 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

3.03 PIPING INSTALLATION

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

B. Install refrigerant piping according to ASHRAE 15.

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

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

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

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

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

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.

2. Install horizontal suction lines with a uniform slope downward to compressor.

3. Install traps and double risers to entrain oil in vertical runs.

4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves according to Section 15190 "Identification for HVAC Piping and Equipment."

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 15093 "Sleeves and Sleeve Seals for HVAC Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 15093 "Sleeves and Sleeve Seals for HVAC Piping."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 15098 "Escutcheons for HVAC Piping."

3.04 PIPE JOINT CONSTRUCTION

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

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

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.

2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

3.05 HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Section 15140 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.

2. Spring hangers to support vertical runs.

3. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

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

1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.

2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch .

3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.

4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.

5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.

3.06 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.

2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.

3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

a. Fill system with nitrogen to the required test pressure.

b. System shall maintain test pressure at the manifold gage throughout duration of test.

c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.

d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.07 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.

3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig .

4. Charge system with a new filter-dryer core in charging line.

3.08 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.

2. Verify that compressor oil level is correct.

3. Open compressor suction and discharge valves.

4. Open refrigerant valves except bypass valves that are used for other purposes.

5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 15566

ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Electric Unit Heaters

1.02 REFERENCES

American Society of Mechanical Engineers (ASME).

National Fire Protection Association (NFPA).

Underwriters Laboratories, Inc. (UL).

National Electric Code (NEC).

1.03 SUBMITTALS

A. Submit shop drawings and manufacturer catalog data with all required accessories as indicated on the drawings and as specified herein.

PART 2 - PRODUCTS

2.01 ELECTRIC UNIT HEATERS

A. The cabinet shall be of heavy gauge steel welded and phosphatized; then completely painted by a baked enamel painting process.

B. Front and back panels shall be removable for service.

C. Architectural design grille shall be 16 gauge steel, with closely spaced down flow discharge bars. Finish shall be heat-resistant baked enamel with satin finished aluminum frame. Grille attachment screws shall be at bottom of grille frame to discourage tampering.

D. Fan motor shall be totally enclosed and permanently lubricated, suitable for horizontal or vertical application.

E. Heating elements shall consist of steel finned and metal sheath construction. The heating element shall cover the entire air discharge area for uniform heating. The

heating element shall be warranted for five years.

F. Heater shall contain automatic reset thermal overheat protector to disconnect power in event of overheating due to accidental blockage.

G. All heater and control wiring shall terminate in the control box. The control box shall be located at the bottom of the heater and equipped with a swing down hinge cover to permit full access for installation and servicing without dismounting the heater. Proper wiring diagrams shall be attached to the inside cover of the control box.

H. Electric Unit Heaters shall be UL listed.

I. Provide a low voltage thermostat (24 volt) 35 degrees F to 85 degrees F range for remote mounting. Provide internal transformers, relay's necessary to facilitate the remote thermostat.

J. Unit heaters shall be Indeeco or approved equal.

PART 3 - EXECUTION

A. Install unit heater according to manufacturer’s installation instruction and mechanical drawings.

B. Provide necessary wiring for remote thermostat, locate according to mechanical drawings.

C. Provide necessary structural steel, threaded rod, etc. for a complete installation.

END OF SECTION

SECTION 15700

SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

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

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.

b. For Parts: One year from date of Substantial Completion.

c. For Labor: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1. Carrier Corporation; a unit of United Technologies Corp.

2. Trane.

3. Mitsubishi Electric

2.02 INDOOR FAN COIL UNIT (5 TONS OR LESS)

A. Ceiling Recessed, Evaporator-Fan Components:

1. Cabinet: The cabinet shall be formed from galvanized sheet metal coated with high-density foam insulation. Cabinet shall be for recessed mounting and provided with four (4) corner mounting supports behind removable corner pockets in Grille assembly allowing adjustment of mounting height from front of unit. The cabinet panel shall have provisions for a field installed filtered outside air intake

2. Refrigerant Coil: The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. Provide optional drain pan level switch on the condensate pan to prevent condensate from overflowing.

3. Fan:

    a. The indoor unit shall be an assembly with a turbo fan propeller, direct driven by a single motor and shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.. The indoor fan shall consist of three (3) speeds. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.

    b. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 16.

    c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

4. Vanes:

    a. There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall significantly decrease downward air resistance for lower sound levels, and shall close the outlet port when operation is stopped. There shall also be a set of vertical vanes to provide horizontal swing airflow movement.

5. Electrical:

    a. The electrical power of the unit shall be 208 volts or 230 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 187 volts to 253 volts. The power to the indoor unit shall be supplied from the outdoor unit.

6. Filters:

    a. Return air shall be filtered by means of an easily removable, long life, washable filter. Filters shall comply with comply with NFPA 90A and minimum MERV rating according to ASHRAE 52.2.

7. Performance:

a. Minimum performance shall be 19.3 SEER and 10.1 HSPF.

2.03 OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: The casing shall be constructed from galvanized steel plate, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection.

2. Compressor: The compressor shall be a DC twin-rotor rotary compressor with Variable Speed Inverter. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which shall result in significant energy savings. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration

3. Refrigerant: R-410A.

4. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

5. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.

6. Fan: Fan shall be furnished with a single DC fan motor with integral thermal-overload protection. The fan blade(s) shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated.

7. Electrical:

a. The electrical power of the unit shall be 208 volts or 230 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 187 volts to 253 volts. The power to the indoor unit shall be supplied from the outdoor unit.

2.04 ACCESSORIES

A. Control equipment and sequence of operation are specified on the drawings.

B. Refer to mechanical schedules for accessories.

2.05 CAPACITIES AND CHARACTERISTICS

A. Refer to mechanical schedules.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.03 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

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

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.04 STARTUP SERVICE

A. Perform startup service.

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

END OF SECTION

SECTION 15754

CENTRIFUGAL FANS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide ventilating systems as indicated on the drawings and as specified herein with all accessories required for proper system balance.

1.02 REFERENCES

Air Diffusion Council (ADC).

Air Movement and Control Association (AMCA).

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

National Fire Protection Association (NFPA).

Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

Underwriter's Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Submit catalog data and shop drawings for all materials and equipment listed under this section.

B. Submit copy of manufacturer’s five year (minimum) warranty for products specified herein.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Provide and install equipment with performance as indicated on fan schedule. Products by Greenheck, Acme, Trane, Cook, Aerovent, Hartzell, New York Blower, Twin Cities, or equal will be considered.

B. Proposed fan selections shall not decrease motor horsepower at all, nor increase brake horsepower (wattage), increase noise level, or increase tip speed by more than 10 percent, or increase inlet air velocity by more than 20 percent, from that specified

or indicated on scheduled fan performance.

C. Air handling unit fans shall be provided by unit manufacturer and are specified elsewhere.

2.02 SELECTION AND BALANCING

A. Fan performance shall be based on standard air conditions.

B. Refer to Fan Schedule.

C. Provide fans capable of accommodating static pressure variations of plus or minus 30 percent.

D. Provide balanced variable sheaves for motors 15 HP and under. Provide solid sheaves for larger motors. Provide necessary changes for sheaves during balancing (Adjustable sheaves may be used for balancing).

E. Statically and dynamically balance fans to eliminate vibration or noise transmission to occupied areas of the building. Spin balance to 125% of selected operating speed (maximum tolerance, guaranteed in writing, one mil double amplitude at design speed).

F. Provide fans matching Schedules with regard to style (i.e. SWSI), Fan Class (i.e. Class II), AMCA drive arrangement (i.e. Arrangement 10), AMCA rotation and discharge (i.e. CCW - BAU), and if necessary, AMCA motor position.

2.03 PAINTING

A. Entire fan including housing interior and exterior, backdraft dampers, roof curb, fan blades and motor cover shall be coated with Hi-Pro Polyester or Heresite 500 series air dry phenolic coating, 3 mils DFT minimum

2.04 MOTORS AND DRIVES

A. Motors: As indicated, in compliance with Section 15170. Motor bearings shall be sealed and permanently lubricated.

B. Shafts: Hot rolled carbon steel, ground and polished, with key-way; protectively coated with lubricating oil. Shafts shall be designed to give safe deflection and operate well below first critical speed.

C. Bearings: ANSI/AFBMA 9, L-10 life at 50,000 hours (L-10 life of 200,000 hours)(L-50 life at 100,000 hours) heavy duty pillow block type, self-aligning, grease-lubricated anti-friction ball bearings.

D. ANSI/AFBMA 11 L-10 life at 50,000 hours (L-50 life at 100,000 hours) heavy duty pillow block type, self-aligning, grease-lubricated roller bearings.

E. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Variable and adjustable pitch sheaves for motors 15 hp and under selected so required rpm is obtained with sheaves set at mid-position; fixed sheaves for 20 hp and over; matched belts; drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.

F. Belt Guard: Fabricate to SMACNA Low Pressure Duct Construction Standards; of 12 gage, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer while guard is in place. Provide guards for all belt drives not enclosed by a weather cover.

2.06 OPTIONS AND ACCESSORIES - GENERAL

A. Provide safety screen where inlet or outlet are exposed, 1" mesh galvanized steel wire with welded grid.

B. Provide engineered vibration isolation frame for individual fans and equivalent vibration isolation provisions for unit-mounted fans.

C. Inlet Bell: Bell mouth inlet for unducted inlet to centrifugal fan, fabricated of steel, aluminum or fiberglass reinforced plastic with flange.

PART 3 - EXECUTION

3.01 CENTRIFUGAL FANS

A. Mount as shown in plans and details and per manufacturer’s installation instructions. Install with resilient mountings and flexible electrical leads (See Sections 15090 and 15095).

B. Provide backdraft dampers for all exhaust fans and as otherwise indicated.

C. Follow SMACNA Guidelines for fan discharge and inlet conditions which are not specifically shown.

D. Secure wall fans with cadmium plated or stainless steel bolts and screws; use lag screws.

E. Provide safety screen where inlet or outlet of fan are exposed to personnel.

END OF SECTION

SECTION 15810

DUCTWORK

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Low pressure ducts.

B. Fasteners.

C. Sealants.

D. Duct cleaning.

1.02 RELATED WORK

A. Section 15140 – Hangers, Supports, and Anchors.

B. Section 15258 – Ductwork Insulation.

C. Section 15980 – Testing, Adjusting and Balancing.

1.03 REFERENCES

A. Air Diffusion Council (ADC).

B. Air Movement and Control Association (AMCA).

C. American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE).

D. National Fire Protection Association (NFPA).

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

F. Underwriters Laboratories, Inc. (UL).

1.04 SUBMITTALS

A. Submit catalogue data and shop drawings for all materials and equipment listed under this section.

PART 2 - PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick

2. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316 as indicated.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Flexible Ducts: Interlocking spiral of galvanized steel or aluminum construction rated to 2 inches WG positive and 1.5 inches WG negative for low pressure ducts or fabric supported by helically wound steel wire or flat steel strips and insulated.

G. Fasteners: Rivets, bolts, or sheet metal screws.

H. Sealant: Shall be non-flammable when wet, fire resistive when dry, and suitable for use in high velocity ductwork. Shall meet NFPA 90A and 90B and be UL classified. Sealant shall have a maximum 25 flame spread and 50 smoke developed (dry state) compound specifically for sealing ductwork. Tape for use with duct sealant shall be specifically designated by the manufacturer for ductwork sealing.

I. Hanger Rod: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

J. Hangers: See Section 15140.

2.05 DUCTWORK APPLICATION SCHEDULE

Air System	Material
General Exhaust	Galvanized Steel and Aluminum
Outside air intake	Galvanized Steel

2.07 LOW PRESSURE DUCT GAGES

A. Rectangular Ducts

Maximum Width (in)	Minimum USS Gage
Up to 12	24
13 to 30	22
31 to 54	20

B. Round Ducts

Duct Diameter (in)	Minimum USS Gage
Up to 13	24
14 to 22	22
23 to 36	20

2.08 DUCTWORK ACCESSORIES

A. General

Provide duct accessories as indicated on the drawings and as required for proper system operation and balance.

B. Flexible Connectors

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Duro Dyne Inc.
   b. Elgen Manufacturing.
   c. Ventfabrics, Inc.
   d. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2. Materials: Flame-retardant or noncombustible fabrics.

3. Coatings and Adhesives: Comply with UL 181, Class 1.

4. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

5. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   a. Minimum Weight: 26 oz./sq. yd..
   b. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   c. Service Temperature: Minus 40 to plus 200 deg F.

6. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   a. Minimum Weight: 26 oz./sq. yd..
   d. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   e. Service Temperature: Minus 40 to plus 200 deg F.

C. Flexible Ducts

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

   a. McGill AirFlow LLC.
   b. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier filmManufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   b. Maximum Air Velocity: 4000 fpm.
   c. Temperature Range: Minus 20 to plus 210 deg F.
   d. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

3. Flexible Duct Connectors:
   a. Clamps: Stainless-steel band with cadmium-plated hex screw to

tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

D. Manual Balancing Dampers

1. Dampers in rectangular ductwork of 12" depth or less shall be single blade type with extended shaft for damper quadrant. Dampers shall be Airstream, Model PBD-5, or approved equal.

2. Dampers in rectangular ductwork of greater than 12" depth shall be opposed blade type, complete with tie rods, and with extended shaft for damper quadrant. Blades shall be 6" width, maximum. Dampers shall be Airstream, Model OBD-11, or approved equal.

3. Dampers in round ductwork shall be single blade type with 20 gauge X 7" long galvanized steel frame and 20 gauge galvanized steel blade. Frames shall be beaded on each end. Shafts shall be 1/2" diameter, mounted with bearings and locking quadrant with insulation standoff. Dampers shall be Ruskin, Model MDRS25 or approved equal by Airstream, Air Balance, Louvers and Dampers or Vent Products.

All dampers shall have an operable blade area equal to the duct net area. No blank off plates will be allowed in place of non-standard blade widths.

F. Damper Quadrants shall have indicators showing open and closed positions, and shall be Ventfabrics, "Ventlock", as follows:

1. Dampers with shaft length 12" or less - No. 620 for base ductwork and No. 637 for insulated ductwork.

2. Dampers with shaft length longer than 12" - No. 637.

G. Turning Vanes

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

   a. Ductmate Industries, Inc.
   b. Duro Dyne Inc.
   c. Elgen Manufacturing.
   d. METALAIRE, Inc.
   e. SEMCO Incorporated.
   f. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

   a. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

3. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

4. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

5. Vane Construction: Double wall

H. Access Door

Duct Access Doors shall be UL labeled, galvanized steel, double panel construction, internally insulated with minimum 1 inch thick fiberglass insulation complete with gaskets and quick opening locking devices in accordance with SMACNA standards. Access doors shall be removable. Access doors with sheet metal screws are not acceptable.

PART 3 - EXECUTION

3.01 GALVANIZED SHEET METAL DUCTWORK

A. Sheet Metal Ductwork shall be fabricated and installed per the latest edition of the SMACNA HVAC duct construction standards and ASHRAE Handbook.

B. All ductwork shall be supported in accordance with SMACNA standards. All threaded rod supports shall be double nutted.

C. Duct transitions shall be gradual, the angle of the side of the transition piece shall not exceed 15 degrees form the straight run of duct extended.

D. All rectangular duct elbows shall be fabricated in accordance with either of the following:

1. Radius Elbow - All radius elbows shall have a centerline radius equal to 1.5 times the width of the duct. This results in an inside radius equal to the width

of the duct. Under no circumstances will radius elbows with a centerline radius of 0.5 times the duct width and an inside radius of 0.0 (90 degrees angle) be allowed.

2. Mitered Elbow (Square Throat - Square Heel) - Where radius elbows will not fit, a mitered elbow will be required. All mitered elbows with an angle over 45 shall be provided with turning valves.

E. All duct sizes shown on plans are net free area.

3.02 DUCT SEALANT

A. All duct systems shall be sealed to meet SMACNA seal class C. Seal per SMCNA recommended methods with sealant or sealant plus tape as appropriate.

3.03 DUCTWORK ACCESSORIES

A. Flexible duct connection shall be installed on all ductwork required to be attached to motor driven equipment.

The ends of the flexible connection shall be overlapped and sealed, to prevent air leakage, per the manufacturer's recommendations. If manufacturer does not have recommended method of sealing, the following method shall be used. Both ends of the flexible connection shall be extended three inches and turned inward (into air stream). Silicone caulking shall be applied between the overlap and outward clinching staples shall be used to fasten the lap.

B. Manual Balancing Dampers, Splitter Dampers, Quadrant Dampers

All damper shall be installed so that damper blades have a full range of movement without interference or binding. Damper quadrant shall be located to provide easy access.

C. Turning Vanes

Turning vanes shall be installed in all mitered (Square Toe-Square Heel) elbows with an angle greater than 45 degrees. Turning vanes shall be 4.5 inches wide, on 3.25 inch centers and be double thickness.

Turning vanes shall be installed tangent to the air stream.

END OF SECTION

SECTION 15941

SEQUENCE OF OPERATIONS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes control sequences for DDC for HVAC systems, subsystems, and equipment.

B. Related Requirements:

1. Section 15955 "TEMPERATURE CONTROLS" for control equipment.

1.03 DEFINITIONS

A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA).

B. Binary Output: On/off output signal or contact closure.

C. DDC: Direct digital control.

D. Digital Output: Data output that must be interpreted digitally.

1.04 ACTION SUBMITTALS

A. Product Data:

1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.

2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.

B. Shop Drawings:

1. Riser diagrams showing control network layout, communication protocol, and wire types.

2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.

3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

1.05 CONTROL SEQUENCES

A. REFER TO MECHANICAL CONTROLS DRAWINGS

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 15955

TEMPERATURE CONTROLS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide a complete automatic temperature control system as indicated on the drawings and as specified herein for proper system control.

B. Provide:

Identification of Controls System Components
Dampers and Actuators
Control System Wiring and Conduit
Sensors, Transmitters, Transducers, Relays, Enclosures
Distributed Processing DDC
Training of Operations Personnel
As-Builts and Framed Approved Control Diagrams

1.02 SUBMITTALS

A. Manufacturer's literature and data for all components including the following:

1. Controllers
2. Control Dampers, Control Valves and Actuators
3. Temperature Control Panel Sizes and Faseplate Layout
4. Instrumentation Products

B. Control Drawings:

1. One set of reproducible drawings
2. One complete set of prints

1.03 CONTROL SYSTEMS

A. Furnish and install complete and ready for operation with control sequences as indicated on the drawings.

B. Control equipment, except for items comprising an integral part of the water or refrigeration system, shall be installed by trained mechanic employed by the control contractor.

C. Include the services of a full time control technician for calibrating controls for the first 5 working days after owner has occupied building.

D. Before installation, submit for approval one set of reproducible drawings and one complete set of diagrams. Hang a photostatic copy of the approved diagram, framed behind glass in each mechanical room. Provide one set of reproducible "As-Built" control diagrams at completion of the project for the Owners use.

E. Provide permanent nameplates for control switches and motor starters. Nameplates: Engraved laminated plastic with letters legible under normal operating conditions (White on Black).

F. Permanently identify control devices other than room thermostats, so they may be identified on control diagrams. Provide engraved plastic nameplates for items mounted outside of or on faces of panels. Mark other instruments with inducible ink.

G. The control contractor shall have a five year record of installation and service of temperature controls within Orlando area for similar types of systems. Acceptable manufacturers are Honeywell, Barber Coleman and Johnson Controls.

1.04 CONTROL WIRING

A. Include all control and interlocking wiring and power wiring for control panel in this section. Install in conduit in accordance with provisions of the electrical specifications.

B. Firestop conduit penetrations of fire rated walls and partitions.

C. Wire all devices individually to terminal strips in control panels.

D. Furnish necessary relays and auxiliary contactors and other accessories required. Provide interlock relays per N.E.C. Coordinate start-up stations, auxiliary contacts, etc., with supplier of starters and motor control centers specified in electrical work.

PART 2 - PRODUCTS

2.01 ELECTRONIC TEMPERATURE SENSORS

A. Electronic temperature sensors shall be of corrosion resistant construction, tamper proof, suitable for mounting on a vibrating surface.

B. All duct mounted temperature sensors (except outdoor and return air) shall have a minimum 20 foot capillary average element.

C. All sensing elements for water pipe mounting shall be furnished complete with protecting wells filled with heat conducting compound.

D. Space temperature sensors shall be provided with room type locking covers.

E. Sensors shall be factory calibrated and shall be thin film platinum.

2.02 AUTOMATIC DAMPERS

Automatic dampers shall be opposed blade type with adjacent blades rotating in opposite directions. They shall be furnished in standard sizes using damper louvers 4 inches in width. Damper blade length shall be a minimum of 12 inches to a maximum of 48 inches. Where larger dampers are required, provide the necessary shaft and blade linkages to allow multiple sections to operate as a single damper. Dampers shall be provided with solid stops for tight closing with vinyl seals on the blade edges and flexible metal compression type sides of the damper frame, which will stand a temperature of up to 200 degrees F. These stops shall be so assembled that they may be easily replaced if they become damaged. Dampers shall be tightly closing and shall be capable of less than 1% at the applied static pressure. Bearings shall be oilite or nylon. Damper linkage shall be provided either linear or equal percentage air flow.

2.03 VALVE AND DAMPER ACTUATORS

Electric valve and damper motors shall have oil immersed gear trains and spring return to normal position.

2.04 MISCELLANEOUS

A. Provide standoffs for control devices mounted on externally insulated ducts and equipment.

B. Anchor all items mounted on gypsum board (dry-wall) using toggle bolts or moly bolts, not expansion shields.

2.05 SOFTWARE

A. Each direct digital controller shall contain all custom and standard programs necessary to accomplish the sequence of operation specified for the equipment it serves and perform the energy management function specified in the Data and Control Summary.

B. All custom software to accomplish the sequence of control shall be generated in the manufacturer's local office and shall be tested and de-bugged prior to its installation at the job site. The DDC system shall provide a real time control language for user programming of HVAC application designed to accomplish easy transition from hardware control system design to software based control system design. The custom software shall allow the user to program custom control sequences directly into micro-computer memory.

PART 3 - EXECUTION

3.01 FINAL ADJUSTMENT

Shall be performed by a factory trained technician to make all final control adjustments. The Temperature Control Contractor shall work closely with the Testing, Adjusting and Balancing contractor to troubleshoot and calibrate systems installed under this section for proper operation and balance.

3.02 TRAINING FOR OPERATION PERSONNEL

The Temperature Controls Contractor shall conduct suitable training period for the Owner's representative to properly explain all facets of the control system operation.

3.03 ACCEPTANCE, GUARANTEE AND SERVICE

All components, parts, and assemblies shall be guaranteed against defects in workmanship and materials for a period of one year after acceptance. In addition, the Control Contractor shall provide prevention maintenance, operator instruction, and system maintenance training through one (1) full heating and cooling season.

END OF SECTION

SECTION 15980

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

2. Testing, Adjusting, and Balancing Equipment:

a. Motors.

b. Condensing units.

c. Heat-transfer coils.

3. Control system verification.

1.03 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.

2. Serial number.

3. Application.

4. Dates of use.

5. Dates of calibration.

1.05 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.

2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

B. TAB Specialists Qualifications: Certified by TABB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by TABB

2. TAB Technician: Employee of the TAB specialist and certified by TABB as a TAB technician.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

1.06 FIELD CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in

SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M. Examine operating safety interlocks and controls on HVAC equipment.

N. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.

2. Strategies and step-by-step procedures for balancing the systems.

3. Instrumentation to be used.

4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.

d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 15810 "Ductwork."

3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 15258 "Duct Insulation," and Section 15256 "HVAC and Plumbing Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 15815 "Metal Ducts."

3.05 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.

2. Motor horsepower rating.

3. Motor rpm.

4. Phase and hertz.

5. Nameplate and measured voltage, each phase.

6. Nameplate and measured amperage, each phase.

7. Starter size and thermal-protection-element rating.

8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.06 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record fan and motor operating data.

3.07 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

3.11 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.

2. Confirm that the sequences of operation are in compliance with Contract Documents.

3. Verify that controllers are calibrated and function as intended.

4. Verify that controller set points are as indicated.

5. Verify the operation of lockout or interlock systems.

6. Verify the operation of valve and damper actuators.

7. Verify that controlled devices are properly installed and connected to correct controller.

8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.

9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.12 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.

2. Air Outlets and Inlets: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.14 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.

2. Fan curves.

3. Manufacturers' test data.

4. Field test reports prepared by system and equipment installers.

5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.

2. Name and address of the TAB specialist.

3. Project name.

4. Project location.

5. Architect's name and address.

6. Engineer's name and address.

7. Contractor's name and address.

8. Report date.

9. Signature of TAB supervisor who certifies the report.

10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.

13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.

15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.

2. Water and steam flow rates.

3. Duct, outlet, and inlet sizes.

4. Pipe and valve sizes and locations.

5. Terminal units.

6. Balancing stations.

7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.

f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft.
h. Tube size in NPS.
i. Tube and fin materials.

j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Refrigerant expansion valve and refrigerant types.
i. Refrigerant suction pressure in psig.
j. Refrigerant suction temperature in deg F.

G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm.
i. Face area in sq. ft.
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.

c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

K. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.15 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager.

B. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

3. If the second verification also fails, Owner may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.16 ADDITIONAL TESTS

A. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

DIVISION 16

ELECTRICAL

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 16, ELECTRICAL. Work specified herein shall be performed as if specified in the individual sections.

1.02 DESIGN REQUIREMENTS

A. All electronic boards as part of electrical equipment shall meet the atmospheric conditions of the space the equipment is installed in. All electronic boards that are not installed in a conditioned environment shall be fungus-resistant,

B. All electrical equipment shall be rated for the conditions the equipment is installed in.

1.03 ELECTRICAL COORDINATION

A. Major Work Provided Under this Contract:

1. Modify the existing MCC-301 at the existing Chemical Building (to be renamed to Maintenance Building) as shown on drawings for a complete and working MCC system in place. New MCC buckets to be installed in existing MCC shall match type, model with existing.
2. See electrical drawings for electrical demolition requirements of existing equipment in the Chemical Building and perform accordingly. Provide and install new electrical system and make all electrical modifications as shown on drawings and as describes in specifications for Maintenance building (former Chemical building) complete in place
3. Provide and install new lighting systems, convenience power systems, and communication raceway system as shown in the drawings and as described in specifications complete in place.
4. Provide and install new access control systems as shown in the drawings and as described in specifications complete in place.
5. Provide and install all conduit and wire to support instrumentation and control systems, fire alarm system, and access control system, unless otherwise noted in the drawings and specifications, complete in place.

6. Provide and install new fire alarm system and Access control system as shown on drawings and as specified in specification 16722 and 16730 complete in place.
7. Provide all miscellaneous electrical including disconnect switches, terminations, fittings, etc. not specified but obviously necessary for complete working systems in place.
8. Contractor shall coordinate with I&C, Mechanical, HVAC and Generator Contractor for all required wire, conduit, power and signal requirements for all package system. Contractor shall review all Mechanical, I&C, HVAC and other systems shop drawings for all electrical requirements and provide all materials and labor as necessary.
9. Electrical Contractor shall be responsible for providing all conduits related to the access control system and fire alarm system. All the above sub-contractors (access control system supplier and fire alarm system supplier) will be installing the associated system under the supervision of the Electrical Contractor so that no additional low voltage permit will be needed. Electrical Contractor shall coordinate with Sub-Contractors to meet all requirements to fall under the Electrical Contractor's low voltage permit before bidding. If sub-contractors do not meet the requirements to fall under the Electrical Contractor's low voltage permit, they shall supply additional permit as needed with no additional cost to the Owner.

I. Temporary Power:

1. Contractor shall furnish and install temporary construction power and temporary distribution system to Contractor's and Engineer's trailers. Contractor shall coordinate all construction power with the local power utility.

1.04 SUBMITTALS

A. The following information shall be provided for all electrical equipment:

1. A copy of each specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation.

2. Electrical equipment submittals shall be made by specification section. Submit one package per specification section and do not group multiple specification sections under one submittal package.
3. Provide complete conduit and equipment layouts: a scaled plan layout of the electrical room(s) showing spatial relationships of all equipment as well as the overall size of the room. Minimum scale shall be ¼”=1’-0”.
4. Provide a conduit plan for major power, instrumentation and control conduits, both interior and exterior, showing routing, size and stub up locations for buried or in slab conduits.

B. As part of the electrical submittal, the contractor shall provide a minimum of ¼”=1’-0” scaled layout of the electrical equipment in the electrical room or major electrical equipment in a mechanical room showing sizes of all equipment and their spatial relationship. For well house, submit a scaled well house layout showing the electrical equipment and panels. Non-electrical equipment shall be approved before finalizing the electrical layout in mechanical rooms.

1.05 ENVIRONMENTAL CONDITIONS

A. All chemical rooms and areas shall be corrosive areas.

B. All indoor chemical and process equipment areas shall be considered wet locations.

1.06 INSPECTION OF THE SITE AND EXISTING CONDITIONS

A. The Electrical Drawings were developed from past record drawings and information supplied by the OWNER. Verify all scaled dimensions prior to submitting bids.

B. Before submitting a bid, visit the site and determine conditions at the site and at all existing structures in order to become familiar with all existing conditions and electrical system which will, in any way or manner, affect the work required under this Contract. No subsequent increase in Contract cost will be allowed for additional work required because of the CONTRACTOR's failure to fulfill this requirement.

C. Carry out any work involving the shutdown of the existing services to any piece of equipment now functioning in existing areas at such time as to provide the least amount of inconvenience to the OWNER. Do such work when directed by the ENGINEER.

D. After award of Contract, locate all existing underground utilities at each area of construction activity. Protect all existing underground utilities during

construction. Pay for all required repairs without increase in Contract cost, should damage to underground utilities occur during construction.

1.07 RESPONSIBILITY

A. The CONTRACTOR shall be responsible for:

1. Complete systems in accordance with the intent of these Contract Documents.
2. Coordinating the details of facility equipment and construction for all Specification Divisions that affect the work covered under Division 16, ELECTRICAL.
3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
4. Coordinating with new or existing doors for bringing the equipment into the room or building. Make all necessary modifications to the structure or equipment without additional cost to the Owner.
5. Yard conduit routings are shown for approximate location only. Contractor shall field determine the appropriate routing to avoid conflicts.

1.08 INTENT OF DRAWINGS

A. Electrical plan Drawings show only general location of equipment, devices, and raceway, unless specifically dimensioned. The CONTRACTOR shall be responsible for the proper routing of raceway, appropriate location and height of equipment, subject to the approval of the ENGINEER.

B. All electrical equipment sizes and characteristics have been based on manufacturer **Square D and Eaton (Cutler-Hammer),** except otherwise noted in the drawings. If the CONTRACTOR chooses to and is allowed to substitute, the CONTRACTOR shall be responsible for fitting all the equipment in the available space as shown on the Drawings.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide materials and equipment listed by UL wherever standards have been established by that agency.

B. Equipment Finish:

1. Provide manufacturers' standard finish and color, except where specific color is indicated.

2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.

PART 3 - EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

3.02 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.03 STARTUP

A. Startup:

1. Demonstrate satisfactory operation of all 480-volt electrical equipment. Participate with other trades in all startup activities.
2. Assist the PICS Contractor in verifying signal integrity of all control and instrumentation signals.

3.04 STANDARDS, CODES, PERMITS, AND REGULATIONS

A. Perform all work; furnish and install all materials and equipment in full accordance with the latest applicable rules, regulations, requirements, and specifications of the following:

1. Local Laws and Ordinances.
2. State and Federal Laws.
3. National Electrical Code (NEC).

4. State Fire Marshal.
5. Underwriters' Laboratories (UL).
6. National Electrical Safety Code (NESC).
7. American National Standards Institute (ANSI).
8. National Electrical Manufacturer's Association (NEMA).
9. National Electrical CONTRACTOR's Association (NECA) Standard of Installation.
10. Institute of Electrical and Electronics Engineers (IEEE).
11. Insulated Cable Engineers Association (ICEA).
12. Occupational Safety and Health Act (OSHA).
13. National Electrical Testing Association (NETA).
14. American Society for Testing and Materials (ASTM).

B. Conflicts, if any, which may exist between the above items, will be resolved at the discretion of the ENGINEER.

C. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

D. Obtain all permits and pay all fees required by any governmental agency having jurisdiction over the work. Arrange all inspections required by these agencies. On completion of the work, furnish satisfactory evidence to the ENGINEER that the work is acceptable to the regulatory authorities having jurisdiction.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American National Standards Institute (ANSI):
   a. C55, 1, Standard for Shunt Power Capacitors.
   b. C62.11, Standard for Metal-Oxide Surge Arrestors for AC Circuits.
   c. Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
2. American Society for Testing and Materials (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A240, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
   c. A570, Standard Specification for Steel, Sheet, and Strip, Carbon, Hot-Rolled, Structural Quality.
3. Federal Specifications (FS):
   a. W-C-596, Connector, Receptacle, Electrical.
   b. W-S-896E, Switches - Toggle, Flush Mounted.
4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. AB 1 Molded Case Circuit Breakers and Molded Case Switches.
   c. CP I, Shunt Capacitors.
   d. ICS 2, Industrial Control Devices, Controllers, and Assemblies.
   e. KS 1, Enclosed Switches.
   f. LA I, Surge Arrestors.
   g. PB 1, Panelboards.
   h. ST 20, Dry-Type Transformers for General Applications.
   i. WD I, General Requirements for Wiring Devices.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories, Inc. (UL):
   a. 67, Standard for Panelboards.
   b. 98, Standard for Enclosed and Dead-Front Switches.
   c. 198C, Standard for Safety High-Intermpting-Capacity Fuses, Current-Limiting Types.

d. 198E, Standard for Class Q Fuses.
e. 486E, Standard for Equipment Wiring Terminals.
f. 489, Standard for Molded Case Circuit Breakers and Circuit Breaker Enclosures.
g. 508, Standard for Industrial Control Equipment.
h. 810, Standard for Capacitors.
i. 943, Standard for Ground-Fault Circuit Interrupters.
j. 1059, Standard for Terminal Blocks.
k. 1561, Standard for Dry-Type General-Purpose and Power Transformers.

1.02 SUBMITTALS

A. Shop Drawings:

1. Device boxes for use in hazardous areas.
2. Junction and pull boxes used at, or below, grade.
3. Hardware.
4. Terminal junction boxes.
5. Panelboards and circuit breaker data.
6. Fuses.
7. Contactors.
8. Transformers.
9. All other miscellaneous material part of this project.
10. Wire pulling compound.

B. Quality Control Submittals:

1. Test Report: Sound test certification for dry type power transformers (O to 600-volt, primary).

1.03 QUALITY ASSURANCE

A. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

B. Hazardous Areas: Materials and devices shall be specifically approved for hazardous areas of the class, division, and group shown and of a construction that will ensure safe performance when properly used and maintained.

C. All references to a particular manufacturer in part 2 of this specification, unless noted as “not approved equal”, are given on an “approved equal” basis. The manufacturer and product listed by name in part 2 to establish a standard quality and other products of the same generic types meeting the specification may be submitted to the Engineer for approval.

PART 2 - PRODUCTS

2.01 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.

B. Cast Metal:

1. Box: Cast ferrous metal.
2. Cover: Gasketed, weatherproof, cast ferrous metal, with stainless steel screws.
3. Hubs: Threaded.
4. Lugs (Cast Mounting) Manufacturer:
    a. Crouse-Hinds; Type FS or FD.
    b. Appleton; Type FS or FD.
    c. Or equal.

C. Cast Aluminum:

1. Material:
    a. Box: Cast, copper-free aluminum.
    b. Cover: Gasketed, weatherproof, cast copper-free aluminum with stainless steel screws.
2. Hubs: Threaded.
3. Lugs: Cast mounting.
4. Manufacturers:
    a. Crouse-Hinds; Type FS-SA or FD-SA.
    b. Appleton; Type FS or FD.
    c. Or equal.

D. Nonmetallic: (use only if shown in drawings)

1. Box: PVC.
2. Cover: PVC, weatherproof, with stainless steel screws.
3. Manufacturer: Carlon; Type FS or FD, with Type E98 or E96 covers, or equal.

2.02 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Article OUTLET AND DEVICE BOXES.

B. Large Stainless Steel Box: NEMA 250, Type 1.

1. Box: 316 stainless steel.
2. Cover: Full access, screw type.
3. Machine Screws: Corrosion-resistant.

C. Large Stainless Steel Box: NEMA 250, Type 4X.

1. Box: 14-gauge, ASTM A240, Type 316 stainless steel.
2. Cover: Hinged with screws.
3. Hardware and Machine Screws: ASTM A167, Type 304 stainless steel.
4. Manufacturers:
   a. Hoffman Engineering Co.
   b. Robroy Industries.
   c. Or equal.

D. Large Steel Box: NEMA 250, Type 4.

1. Box: 12-gauge steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces, with final ANSI Z55.1, No. 61 gray enamel on exterior surfaces.
2. Cover: Hinged with screws.
3. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
4. Manufacturers:
   a. Hoffman Engineering Co.
   b. Robroy Industries.
   c. Or equal.

E. Large Nonmetallic Box: (Use only if shown on drawings or corrosive areas)

1. NEMA 250, Type 4X.
2. Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat.
3. Cover: Hinged with screws.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Conduit hubs and mounting lugs.
6. Manufacturers:
   a. Crouse-Hinds; Type NJB.
   b. Carlon; Series N, C, or H.
   c. Robroy Industries.
   c. Or equal.

2.03 WIRING DEVICES

A. Switches:

1. NEMA WD I and FS W-S-896E.
2. Specification grade, totally-enclosed, ac type, with quiet tumbler switches and screw terminals.
3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
4. Rating: 20 amps, 120/277 volts.
5. Color:
    a. Office Areas: Ivory.
    b. Other Areas: Brown.
6. Switches with Pilot Light: 125-volt, neon light with red jewel, or lighted toggle when switch is ON.
7. Manufacturers:
    a. Square D.
    b. Hubbell.
    c. Or equal.

B. Receptacle, Single and Duplex:

1. NEMA WD 1 and FS W-C-596.
2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
3. High strength, thermoplastic base color.
4. Color:
    a. Office Areas: Ivory.
    b. Other Areas: Brown.
    c. UPS power: Red Color Outlet with red device plate, no exception.
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
7. Manufacturers:
    a. Square D.
    b. Hubbell.
    c. Or equal.

C. Receptacle, Ground Fault Circuit Interrupter: Duplex, specification grade, tripping at 5 mA.

1. Color: Ivory.
2. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, capable of interrupting 5,000 amps without damage.
3. Size: For 2-inch by 4-inch outlet boxes.
4. Standard Model: NEMA WD 1 with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.
5. Feed-Through Model: NEMA WD 1, with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.

6. Manufacturers:
    a. Square D GFSR.
    b. Hubbell GF.
    c. Or equal.

D. Receptacle, Special-Purpose:

1. Rating and number of poles as indicated or required for anticipated purpose.
2. Matching plug with cord-grip features for each special-purpose receptacle.

E. Multioutlet Surface Raceway System: Three-wire grounding receptacles, spaced on 6-inch centers with insulated grounding conductor to each receptacle. Minimum 6-receptacles on each multioutlet system.

1. Color: Gray with black receptacles for normal power. Gray with red receptacles for UPS power.
2. Manufacturers:
    a. Plugmold; 2000.
    b. Walker; Duct 2GW.

2.04 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Plastic:

1. Material: Specification grade, 0.10-inch minimum thickness, noncombustible, thermosetting.
2. Color: To match associated wiring device.
3. Mounting Screw: Oval-head metal, color matched to plate.

C. Metal:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

D. Cast Metal:

1. Material: Malleable ferrous metal, with gaskets.
2. Screw: Oval-head stainless steel.

E. Engraved:

1. Character Height: 3/16 inch.
2. Filler: Black.

F. Weatherproof:

1. For Receptacles: Gasketed, cast metal or stainless steel, with individual cap over each receptacle opening.
2. Mounting Screw: Stainless steel.
   a. Cap Spring: Stainless steel.
   b. Manufacturers:
      1) General Electric.
      2) Bryant.
      3) Hubbell.
      4) Sierra.
      5) Pass and Seymour.
      6) Crouse-Hinds; Type WLRD or WLRS.
      7) Bell.
      8) Arrow Hart.
      9) Or equal.
3. For Switches: Gasketed, cast metal incorporating external operator for internal switch.
   a. Mounting Screw: Stainless steel.
   b. Manufacturers:
      1) Crouse-Hinds; DS-181 or DS-185.
      2) Appleton; FSK-LVTS or FSK-IVS.
      3) Or equal.

G. Raised Sheet Metal: 1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel boxes.

2.05 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. NEMA PB I, NFPA 70, and UL 67, including panelboards installed in motor control equipment.

B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

D. Interrupting ratings: as shown on the drawings.

E. Rating: As indicated on drawings and verified by short circuit and device coordination study required by specification section 16015. Final ratings shall be adjusted by recommendations of short circuit and device coordination study.

F. Where ground fault interrupter circuit breakers are indicated or required by code: 5 mA trip, 10,000 amps interrupting capacity circuit breakers.

G. Cabinet: As shown on plans.

H. Bus Bar:

1. Material: Copper, full sized throughout length.
2. Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.
3. Neutral: Insulated, rated 150 percent of phase bus bars with at least one terminal screw for each branch circuit.
4. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
5. Lugs and Connection Points:
   a. Suitable for either copper or aluminum conductors.
   b. Solderless main lugs for main, neutral, and ground bus bars.
   c. Sub feed or through-feed lugs as shown.
6. Bolt together and rigidly support bus bars and connection straps on molded insulators.

I. Circuit Breakers:

1. NEMA AB 1 and UL 489.
2. Thermal-magnetic, quick-make, quick-break, molded case, of the indicating type showing ON/OFF and TRIPPED positions of operating handle.
3. Non-interchangeable, in accordance with NFPA 70.
4. Locking: Provisions for handle padlocking, unless otherwise shown.
5. Type: Bolt-on circuit breakers in all panelboards.
6. Multi-pole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
7. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.
8. Do not use tandem or dual circuit breakers in normal single-pole spaces.
9. Ground Fault Interrupter:
   a. Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5-milliampere ground fault (UL 943, Class A sensitivity).

b. Sensor with same rating as circuit breaker and a push-to-test button.

J. Manufacturers:
1. Cutler-Hammer;
2. Square D;
3. GE;
4. Or equal.

2.06 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA AB I, UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: As shown or as required.

C. Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of the operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Locking: Provisions for padlocking handle.

F. Multi-pole breakers to automatically open all poles when an overload occurs on one-pole.

G. Enclosure: NEMA 250, Type 12, Industrial Use, 4X - outdoors, wet locations and corrosive areas, unless otherwise shown.

H. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.

I. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

J. Manufacturers:
1. Cutler-Hammer;
2. Square D;
3. GE;
4. Or equal.

2.07 FUSED DISCONNECT SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. UL 98 listed for use and location of installation.

B. NEMA KS 1 and UL 98 Listed for application to system with available short circuit current of 22,000 amps rms symmetrical.

C. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Fuse mountings shall reject Class H fuses and accept only current-limiting fuses specified.

F. Enclosure: NEMA 250, Type 12, Industrial Use, 4X - outdoors, wet locations and corrosive areas, unless otherwise shown.

G. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

H. Manufacturers:
   1. Cutler-Hammer;
   2. Square D;
   3. GE;
   4. Or equal.

2.08 NONFUSED DISCONNECT SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Enclosure: NEMA 250, Type 12, industrial use, 4X- outdoors, wet locations and corrosive areas, unless otherwise shown.

E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

F. Manufacturers:
   1. Cutler-Hammer;
   2. Square D;
   3. GE;
   4. Or equal.

2.09 FUSE, 0 TO 600 VOLTS

A. Current-limiting, with 200,000-ampere rms interrupting rating.

B. Provide to fit mountings specified with switches and features to reject Class H fuses.

C. Motor and Transformer Circuits, 0- to 600-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-1, dual element, with time delay.
3. Manufacturers:
   a. Bussmann; Type LPS-RK.
   b. Gould-Shawmut; Type LLS-RK.
   c. Or approved equal.

D. Motor and Transformer Circuits, 0- to 250-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-1, dual element, with time delay.
3. Manufacturers:
   a. Bussmann; Type LPN-RK.
   b. Gould-Shawmut; Type LLN-RK.
   c. Or approved equal.

E. Feeder and Service Circuits, 0- to 600-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-I, dual element, with time delay.
3. Manufacturers:
   a. Bussmann; Type LPS-RK.
   b. Gould-Shawmut; Type LLS-RK.
   c. Or approved equal.

F. Feeder and Service Circuits, O- to 250-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-I, dual element, with time delay.
3. Manufacturers:
   a. Bussmann; Type LPN-RK.
   b. Gould-Shawmut; Type LLN-RK.
   c. Or approved equal.

G. Feeder and Service Circuits, 0- to 600-Volt:

1. Amperage: 601 to 6,000.
2. UL 198C, Class L, double O-rings and silver links.
3. Manufacturers:
    a. Bussmann; Type KRP-C.
    b. Gould-Shawmut; Type KLPC.
    c. Or approved equal.

2.10 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCHES

A. Contact Rating: NEMA ICS 2, Type A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Lights: Push-to-test LED type.

D. Pushbutton Color:

1. ON or START: Black.
2. OFF or STOP: Red.

E. Pushbuttons and selector switches lockable in the OFF position where indicated.

F. Legend Plate:

1. Material: Aluminum.
2. Engraving: 11 character/spaces on one line, 14 character/spaces on each of two lines, as required, and indicating specific function.
3. Letter Height: 7/64 inch.

G. Manufacturers:

1. Heavy-Duty, Oil tight Type:
    a. Square D; Type T.
    b. Cutler-Hammer; Type CH10250T.
    c. Or equal.
2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
    a. Square D; Type SK.
    b. Cutler-Hammer; Type E34.
    c. Or equal.

2.11 TERMINAL BLOCK (0 TO 600 VOLTS)

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of all control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between the compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

1. Capable of wire connections without special preparation other than stripping.
2. Capable of jumper installation with no loss of terminal or rail space.
3. Individual, rail mounted.

I. Marking system: allowed use of preprinted or field-marked tags.

J. Manufacturers:

1. Marathon, series 200.
2. Square D 9070GR6.
3. Or equal.

2.12 MAGNETIC CONTROL RELAY

A. NEMA ICS 2, Class A600 (600 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control with field convertible contacts.

B. Time Delay Relay Attachment:

1. Pneumatic type, timer adjustable from 0.2 to 60 seconds (minimum).
2. Field convertible from ON delay to OFF delay and vice versa.

C. Latching Attachment: Mechanical latch having unlatching coil and coil clearing contacts.

D. Manufacturers:
1. Cutler-Hammer; Type M-600.

2. Square D.
3. Potter Brumfield.
4. Eagle Signal.
5. Or equal.

2.13 MAGNETIC CONTACTOR

A. NEMA ICS 2, UL 508.

B. Electrically operated, electrically held.

C. Main Contacts:

1. Power driven in one direction with gravity dropout.
2. Silver alloy with wiping action and arc quenchers.
3. Continuous-duty, rated 30 amperes, 600-volt.
4. Three-pole.

D. Control: Two-wire.

E. One normally open and one normally closed auxiliary contacts rated 10 amperes at 480-volt.

F. Enclosure: NEMA 250, Type 12, unless otherwise shown.

G. Manufacturers:

1. Cutler-Hammer; ECL Series.
2. General Electric; CR 353.
3. Allen-Bradley; Bulletin 500 Line.
4. Or equal.

2.14 THERMOSTAT

A. Rating: 7.4 amps continuous, 44 amps locked rotor current at 120 volts and 3.7 amps continuous, 22 amps locked rotor current at 240 volts.

B. Line voltage, single-stage, treated to resist corrosion, dust, dirt, and humidity with sealed SPDT contacts.

C. Heating Adjustment Range: 35 to 100 degrees F.

D. Cooling or Ventilating Adjustment Range: 70 to 140 degrees F.

E. Manufacturer: Honeywell; Type T631F1084 or equal.

2.15 SUPPORT AND FRAMING CHANNELS

A. Material:

1. Dry indoors - galvanized.
2. All Other Areas: ASTM A167, Type 316 stainless steel or fiber-reinforced epoxy, as required.

B. Finish:

1. Dry indoors - galvanized.
2. All Other Areas: ASTM A167, Type 316 stainless steel or fiber-reinforced epoxy, as required.

C. Inserts: Continuous.

D. Beam Clamps: Gray cast iron.

E. Manufacturers:
1. B-Line.
2. Unistrut.
3. Or equal.

2.16 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color: White, engraved to a black core.

D. Engraving:

1. Pushbuttons/Selector Switches: Name of drive controlled on one, two, or three lines, as required.
2. Panelboards: Panelboard designation, service voltage, and phases.

E. Letter Height:

1. Pushbuttons/Selector Switches: 1/8 inch.
2. Panelboards: 1/4 inch.

2.17 SURGE PROTECTIVE DEVICE

A. This section describes the material and installation requirements for surge protection devices (SPD) in switchboards, panelboards, and motor control centers for the protection of all AC electrical circuits.

B. SPD's shall be listed and component recognized in accordance with UL 1449 4th addition Type 1 SPD and UL 1283.

C. SPD's shall be installed and warranted by and shipped from the electrical distribution equipment manufacturer's factory.

D. SPD's shall provide surge current diversion paths for all modes of protection; L-L, L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.

E. SPD's shall be modular in design. Each module shall be fused with a surge rated fuse.

F. A UL approved disconnect switch shall be provided as a means of disconnect in the switchboard device only.

G. SPD's shall meet or exceed the following criteria:
   1. Maximum surge current capability (single pulse rated) shall be:
      a. Service entrance switchboard 300kA per phase
      b. Branch panelboards 150kA per phase
      c. Motor control centers 80kA per phase
   2. UL 1449 3rd edition Listed and Recognized Component Voltage Protection Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G
208Y/120	600V	600V	600V
480Y/277	1000V	1000V	1000V

H. SPD's shall have a minimum EMI/RFI filtering of -44dB at 100kHz with an insertion ration of 50:1 using MIL STD. 220A methodology.

I. SPD's shall be provided with 1 set of NO/NC dry contacts.

J. SPD's shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if transients destroy them during the warranty period. Warranty will be the responsibility of the electrical distribution equipment manufacturer.

K. Approve manufactures are:

   1. Cutler Hammer

2. General Electric
3. Siemans
4. Square D Company
5. Current Technology
6. No approved or equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Install equipment in accordance with NECA 5055.

3.02 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in the wiring or raceway system, sized to meet NFPA 70 requirements.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
   a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch sheet steel device box.

C. Locations:

1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by ENGINEER.
3. Light Switch: Install on lock side of doors.
4. Light Fixture: Install in symmetrical pattern according to room layout unless otherwise shown.

D. Mounting Height:

1. General:
   a. Measured to centerline of box.
   b. Where specified heights do not suit building construction or finish, mount as directed by ENGINEER.
2. Light Switch: 48 inches above floor.
3. Thermostat: 54 inches above floor.

4. Telephone Outlet: 6 inches above counter tops or 15 inches above floor.
5. Wall Mounted Telephone Outlet: 52 inches above floor.
6. Convenience Receptacle:
    a. General Interior Areas: 15 inches above floor.
    b. General Interior Areas (Counter Tops): Install device plate bottom or side flush with top of splashback, or 6 inches above countertops without splashback.
    c. Industrial Areas, Workshops: 48 inches above floor.
    d. Outdoor, All Areas: 24 inches above finished grade.
7. Special-Purpose Receptacle: 54 inches above floor or as shown.

E. Install plumb and level.

F. Flush Mounted:

1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
3. Holes in surrounding surface shall be no larger than required to receive box.

G. Support boxes independently of conduit by attachment to building structure or structural member.

H. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws threaded into steelwork.

I. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

J. Provide plaster rings where necessary.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. Install stainless steel mounting hardware in industrial areas.

M. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

N. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.

O. Box Type (Steel Raceway System):

1. Exterior Locations:
    a. Exposed Raceways: Cast metal.
    b. Concealed Raceways: Cast metal.
    c. Concrete Encased Raceways: Cast metal.
    d. Class I, II, or III Hazardous Areas: Cast metal.
2. Interior Dry Locations:
    a. Exposed Rigid Conduit: Cast metal.
    b. Exposed EMT: Sheet steel.
    c. Concealed Raceways: Sheet steel.
    d. Concrete Encased Raceways: Cast metal.
    e. Lighting Circuits, Ceiling: Sheet steel.
    f. Class I, II, or III Hazardous Areas: Cast metal.
3. Interior Wet Locations:
    a. Exposed Raceways: Cast metal.
    b. Concealed Raceways: Cast metal.
    c. Concrete Encased Raceways: Cast metal.
    d. Lighting Circuits, Ceiling: Sheet steel.
    e. Class I, II, or III Hazardous Areas: Cast metal.
4. Cast-In-Place Concrete Slabs: Sheet steel.

P. Box Type (Rigid Aluminum Raceway System): Cast aluminum.

Q. Box Type (Nonmetallic Raceway System):

1. Corrosive Locations: Nonmetallic.
2. Exposed Raceways: Nonmetallic.
3. Concealed Raceways: Nonmetallic.
4. Concrete Encased Raceways: Nonmetallic.

R. Box Type, Corrosive Locations (PVC-Coated Rigid Galvanized Steel Raceway System): PVC coated cast metal.

3.03 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Installed boxes shall be accessible.

F. Do not install on finished surfaces.

G. Install plumb and level.

H. Support boxes independently of conduit by attachment to building structure or structural member.

I. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork.

J. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. At or Below Grade:

1. Install boxes for below grade conduits flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Obtain ENGINEER's written acceptance prior to installation in paved areas, roadways, or walkways.
4. Use boxes and covers suitable to support anticipated weights.

M. Flush Mounted:

1. Install with concealed conduit.
2. Holes in surrounding surface shall be no larger than required to receive box.
3. Make edges of boxes flush with final surface.

N. Mounting Hardware:

1. Non-corrosive Interior Areas: Galvanized.
2. All Other Areas: Stainless steel.

O. Location/Type:

1. Finished, Indoor, Dry: NEMA 250, Type 1.
2. Unfinished, Indoor, Dry: NEMA 250, Type 12.

3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.
5. Unfinished, Indoor and Outdoor, Hazardous: NEMA 250, Type 7 and Type 9, where indicated.
6. Underground Conduit: Concrete Encased.
7. Corrosive Locations: Nonmetallic.

3.04 WIRING DEVICES

A. Switches:

1. Mounting Height: See Paragraph OUTLET AND DEVICE BOXES.
2. Install with switch operation in vertical position.
3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:

1. Install with grounding slot down except where horizontal mounting is shown, in which case install with neutral slot up.
2. Ground receptacles to boxes with grounding wire only.
3. Weatherproof Receptacles:
   a. Install in cast metal box.
   b. Install such that hinge for protective cover is above receptacle opening.
4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for "downstream" conventional receptacles.
5. Special-Purpose Receptacles: Install in accordance with manufacturer's instructions.

3.05 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to the box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Engrave with designated titles.

F. Types (Unless Otherwise Shown):

1. Office: Stainless Steel.
2. Exterior: Weatherproof.
3. Interior:
    a. Flush Mounted Boxes: Stainless Steel.
    b. Surface Mounted, Cast Metal Boxes: Cast metal.
    c. Surface Mounted, Sheet Steel Boxes: Stainless Steel.
    d. Surface Mounted, Nonmetallic Boxes: Plastic.

3.06 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Heavy-Duty, Oil tight Type: Locations (Unless Otherwise Shown): Non-hazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Heavy-Duty, Watertight, and Corrosion-Resistant Type:

1. Locations (Unless Otherwise Shown): Non-hazardous, outdoor, or normally wet areas.
2. Mounting: NEMA 250, Type 4X enclosure.

3.07 TERMINAL JUNCTION BOX

A. Install in accordance with Paragraph JUNCTION AND PULL BOXES.

B. Label each block and terminal with permanently attached, non-destructible tag.

C. Do not install on finished outdoor surfaces.

D. Location:

1. Finished, Indoor, Dry: NEMA 250, Type 1.
2. Unfinished, Indoor, Dry: NEMA 250, Type 12.
3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.

3.08 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. Install securely, plumb, in-line and square with walls.

B. Install top of cabinet 6 feet above floor unless otherwise shown.

C. Provide typewritten circuit directory for each panelboard.

3.09 SUPPORT AND FRAMING CHANNEL

A. Furnish zinc-rich primer; paint cut ends prior to installation, where applicable.

B. Install where required for mounting and supporting electrical equipment and raceway systems.

END OF SECTION

SECTION 16110

RACEWAYS

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): Division I, Standard Specifications for Highway Bridges, Fourteenth Edition.
2. American National Standards Institute (ANSI):
   a. C80.1, Rigid Steel Conduit-Zinc Coated.
   b. C80.3, Electrical Metallic Tubing-Zinc Coated.
   c. CS0.5, Rigid Aluminum Conduit.
   d. C80.6, Intermediate Metal Conduit (IMC)-Zinc Coated.
3. American Society for Testing and Materials (ASTM):
   a. A123 El, Standard Specification for Zinc-Coated (Galvanized) Coatings on Iron and Steel Products.
   b. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.
5. National Electrical Manufacturers Association (NEMA):
   a. RN 1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   b. TC 2, Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
   c. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
   d. TC 6, PVC and ABS Plastic Utilities Duct for Underground Installation.
   e. VE 1, Metallic Cable Tray Systems.
6. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)
7. Underwriters Laboratories, Inc. (UL):
   a. 1, Standard for Safety Flexible Metal Conduit.
   b. 6, Standard for Safety Rigid Metal Conduit.
   c. 360, Standard for Safety Liquid-Tight Flexible Steel Conduit.
   d. 514B, Standard for Safety Fittings for Conduit and Outlet Boxes.
   e. 514C, Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
   f. 651, Standard for Safety Schedule 40 and 80 PVC Conduit.

g. 651A, Standard for Safety Type EB and Rigid PVC Conduit and HDPF Conduit.

h. 797, Standard for Safety Electrical Metallic Tubing.
i. 870, Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings.
j. 1242, Standard for Safety Intermediate Metal Conduit.
k. 1660, Standard for Safety Liquid-Tight Flexible Nonmetallic Conduit.

1.02 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's Literature:
   a. Rigid galvanized steel conduit.
   b. Electric metallic tubing.
   c. Rigid aluminum conduit.
   d. PVC Schedule 40 conduits.
   e. PVC-coated rigid galvanized steel conduit.
   f. Flexible metal, liquid-tight conduit.
   g. Flexible, nonmetallic, liquid-tight conduit.
   h. Conduit fittings.
   i. Wireways.
   j. Detectable electric warning tape.
2. Precast Manholes and Handholes:
   a. Dimensional drawings and descriptive literature.
   b. Traffic loading calculations.
   c. Accessory information.
3. Cable Tray Systems:
   a. Dimensional drawings, calculations, and descriptive information.
   b. NEMA load/span designation and how it was selected.
   c. Support span length and pounds-per-foot actual and future cable loading at locations, with safety factor used.
   d. Location and magnitude of maximum simple beam deflection of tray for loading specified.
   e. Layout drawings and list of accessories being provided.
4. Conduit Layout:
   a. Plan and section type, showing arrangement and location of conduit and duct bank required for:
      1) Low and medium voltage feeder and branch circuits.
      2) Instrumentation and control systems.
      3) Communications systems.
      4) Empty conduit for future use.

b. Reproducible drawings with scale not greater than 1 inch equal 20 feet.

5. Equipment and machinery proposed for bending metal conduit.
6. Method for bending PVC conduit less than 30 degrees.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 - PRODUCTS

2.01 CONDUIT AND TUBING

A. Electric Metallic Tubing (EMT):

1. Meet requirements of ANSI C80.3 and UL 797.
2. Material: Hot-dip galvanized, with chromated and lacquered protective layer.

B. Rigid Aluminum Conduit:

1. Meet requirements of ANSI C80.5 and UL 6.
2. Material: Type 6063, copper-free aluminum alloy.

C. PVC Schedule 40 or 80 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

D. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

E. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Material: PVC core with fused flexible PVC jacket.
2. UL 1660 listed for:
   a. Dry Conditions: 80 degrees C insulated conductors.
   b. Wet Conditions: 60 degrees C insulated conductors.
3. Manufacturers:
   a. Carlon; Carflex or X-Flex.

b. T & B; Xtraflex LTC or EFC.
c. Or equal.

2.02 FITTINGS

A. Electric Metallic Tubing:

1. Meet requirements of UL 514B.
2. Type: Steel body and locknuts with steel or malleable iron compression nuts. Set screw and drive-on fittings not permitted.
3. Compression Ring: Stainless steel.
4. Coupling Manufacturers:
   a. Appleton; Type 95T.
   b. Crouse-Hinds; Type CPR.
   c. Or equal.
5. Connector Manufacturers:
   a. Appleton; Type 86T.
   b. Crouse-Hinds; Type CPR.
   c. Or equal.

B. Rigid Aluminum Conduit:

1. General:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, copper-free. Set screw fittings not permitted.
2. Insulated Bushing:
   a. Material: Cast aluminum, with integral insulated throat, rated for 150 degrees C.
   b. Manufacturer: O.Z. Gedney; Type AB, or equal.
3. Grounding Bushing:
   a. Material: Cast aluminum with integral insulated throat, rated for 150 degrees, with solderless lugs.
   b. Manufacturer: O.Z. Gedney; Type ABLG, or equal.
4. Conduit Hub:
   a. Material: Cast aluminum, with insulated throat.
   b. Manufacturers:
      1) O.Z. Gedney; Type CHA.
      2) T & B; Series 370AL.
      3) Or equal.
5. Conduit Bodies:
   a. Manufacturers (For Normal Conditions):
      1) Appleton; Form 85 threaded Unilets.
      2) Crouse-Hinds; Mark 9 or Form 7-SA threaded condulets.
      3) Killark; Series O Electrolets.
   b. Manufacturers (For Hazardous Locations):

1) Appleton.
2) Crouse-Hinds.
3) Killark.

6. Couplings: As supplied by conduit manufacturer.
7. Conduit Sealing Fitting Manufacturers:
   a. Appleton; Type EYF-AL or EYM-AL.
   b. Crouse-Hinds; Type EYS-SA or EZS-SA.
   c. Killark; Type EY or EYS.
8. Drain Seal Manufacturers:
   a. Appleton; Type EYDM-A.
   b. Crouse-Hinds; Type EYD-SA or EZD-SA.
   c. Or equal.
9. Drain/Breather Fitting Manufacturers:
   a. Appleton; Type ECDB.
   b. Crouse-Hinds; ECD.
   c. Or equal.
10. Expansion Fitting Manufacturers:
   a. Deflection/Expansion Movement: Steel City; Type DF-A.
   b. Expansion Movement Only: Steel City; Type AF-A.
   c. Or equal.
11. Cable Sealing Fittings: To form watertight nonslip cord or cable connection to conduit.
   a. Bushing: Neoprene at connector entry.
   b. Manufacturer: Appleton CG-S, or equal.

C. PVC Conduit and Tubing:

1. Meet requirements of NEMA TC-3.
2. Type: PVC, slip-on.

D. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of UL 514B.
2. Type: Rigid galvanized steel, PVC coated by conduit manufacturer.
3. Overlapping pressure sealing sleeves.
4. Conduit Hangers, Attachments, and Accessories: PVC-coated.

E. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
2. Insulated throat and sealing O-rings.
3. Long design type extending outside of box or other device at least 2 inches.
4. Manufacturer: T & B; Series 5300, or equal.

F. Flexible, Nonmetallic, and Liquid-Tight Conduit: Meet requirements of UL 514B.

1. Type: One-piece fitting body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.
2. Manufacturers:
   a. Carlon; Type LT.
   b. Kellems; Polytuff.
   c. T & B; LT Series.

G. Watertight Entrance Seal Device:

1. New Construction:
   a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
   b. Manufacturer: O.Z./Gedney; Type FSK or WSK, as required or equal.
2. Gored-Hole Application:
   a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
   b. Manufacturer: O.Z./Gedney; Series CSM, or equal.

H. Hazardous Locations: Approved for use in the atmosphere involved.

1. Manufacturer: Crouse-Hinds; Type ECGJH.

I. Corrosive Locations:

1. Material: 40-mil PVC-coated rigid steel.
2. Manufacturers:
   a. Robroy Industries.
   b. Carlon.
   c. Crouse-Hinds.

2.03 WIREWAYS

A. Meet requirements of UL 870.

B. Type: Steel-enclosed, with removable, hinged cover.

C. Rating: Outdoor raintight if outdoor, and indoor if indoor.

D. Finish: Gray, baked enamel.

E. Manufacturers:

1. Square D.
2. B-Line Systems, Inc.
3. Or equal.

2.04 CABLE TRAYS

A. Meet requirements of NEMA VE 1.

B. Type: Ladder of welded construction.

C. Material: Copper-free aluminum alloys 6063-T6 finishes.

D. Cover: Louvered, minimum 0.40-inch thick aluminum.

E. Barrier Strip: Vertical, solid type, with horizontal fittings and strip clamps.

F. Fittings of same cross-sectional tray area, and hardware of same material as cable tray.

G. Tray Grounding: Conform to NFPA 70 and NEMA VE 1.

H. Provide next higher NEMA VE 1 class designation than required for support of designed span length.

I. Design Loads: Use working load adequate for actual cable installed plus 50 percent additional weight allowance for future cables plus 200-pound concentrated static load applied between side rails at midspan, with safety factor of 2 in accordance with NEMA VE 1, Table 3-1.

J. Expansion Joints: NEMA VE 1 for 50 degrees F maximum temperature variation.

K. Furnish Cable Tray with no sharp edges, burrs, or weld projections.

L. Manufacturers:

1. B-Line Systems, Inc.
2. Square-D.
3. P. W. Industries.

2.05 PRECAST MANHOLES AND HANDHOLES

A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

B. Loading: AASHTO Division 1, H-20 in accordance with ASTM C857.

C. Access: Provide cast concrete 6- or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.

D. Drainage:

1. Slope floors toward drain points, leaving no pockets or other non-draining areas.
2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe.

E. Raceway Entrances:

1. Provide on all four sides.
2. For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.
3. At entrances where raceways are to be installed by others, provide minimum 12-inch high by 24-inch wide knockout panels for future raceway installation.

F. Embedded Pulling Iron:

1. Material: 3/4-inch diameter stock, fastened to overall steel reinforcement before concrete is placed.
2. Location:
   a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
   b. Floor: Centered below manhole or handhole cover.

G. Cable Racks:

1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
2. Wall Attachment:
   a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
   b. Insert Spacing: Maximum 3-foot on center entire inside perimeter of manhole.
   c. Arrange so that spare raceway ends are clear for future cable installation.

H. Manhole Frames and Covers:

1. Material: Machined cast iron.

2. Cover Type: Indented, solid top design, with two drop handles each.
3. Cover Loading: AASHTO Division I, H-20.
4. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
    a. Above 600 Volts: ELECTRIC HV.
    b. 600 Volts and Below: ELECTRIC LV.
    c. TELEPHONE.

I. Handhole Frames and Covers:

1. Material: Steel, hot-dipped galvanized.
2. Cover Type: Solid, bolt on, of checkered design.
3. Cover Loading: H-20.
4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
    a. 600 Volts and Below: ELECTRIC LV.
    b. TELEPHONE.
5. Manufacturers:
    a. US Foundry.
    b. Vulcan.
    c. Or equal.

J. Hardware: Steel, hot-dip galvanized.

K. Furnish knockout for ground rod in each handhole and manhole.

L. Manufacturers:

1. Allied Precast.
2. Atlantic Precast, Inc.
3. Dura Stress, Inc.
4. Mack Precast.
5. Standard Precast, Inc.
6. Hanson Pipe & Products.
7. Oldcastle Precast.
8. Delzotto Precast.

2.06 ACCESSORIES

A. Duct Bank Spacers:

1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturer: Underground Device, Inc.; Type WUNPEECE, or equal.

B. Identification Devices:

1. Raceway Tags:
   a. Material: Permanent, nylon.
   b. Shape: Round.
   c. Raceway Designation: Pressure stamped, embossed, or engraved.
   d. Tags relying on adhesives or taped-on markers not permitted.
2. Detectable Electric Warning Tape:
   a. Material: Polyethylene, 4-mil gauge.
   b. Color: Red.
   c. Width: Minimum 6-inch.
   d. Designation: Warning on tape that electric circuit is located below tape.
   e. Manufacturers:
      1) Blackburn, Type RT.
      2) Griffolyn Co.
3. Buried Raceway Marker:
   a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where routing changes direction.
   b. Designation: Incise to depth of 3/32 inch, ELECTRIC CABLES in letters 1/4-inch high.
   c. Minimum Dimension: 1/4-inch thick, 10 inches long and 3/4-inch wide.
4. Electronic Marker Systems
   a. Manufacturer: 3M
      1) Scotchmark EMS11 Electronic Marker Locator #125.
      2) Scotchmark electronic marker.
      3) Greenball marker #1404

C. Raceway Coating:

1. Material: Bitumastic or plastic tape coating.
2. Manufacturers:
   a. Koppers bitumastic; No. 505.
   b. Scotchwrap; No. 51, plastic tape.
   c. Or approved equal.

D. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
2. Manufacturer: Raychem; Type TWDB.

PART 3 - EXECUTION

3.01 GENERAL

A. Conduit and Tubing sizes shown are based on the use of copper conductors. Reference Section 16120, CONDUCTORS, concerning conduit sizing for aluminum conductors.

B. All installed Work shall comply with NECA 5055.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Aluminum Conduit: Do not install in direct contact with concrete.

G. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

I. Group raceways installed in same area.

J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

M. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.

N. Install watertight fittings in outdoor, underground, or wet locations.

O. Paint threads, before assembly of fittings, of galvanized conduit or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

P. All metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

Q. Do not install raceways in concrete equipment pads, foundations, or beams.

R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

3.02 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch; Underground: 1 inch.

B. Exterior, Exposed:

1. Rigid aluminum.

C. Interior, Exposed:

1. Rigid aluminum.

D. Interior, Concealed (Not Embedded in Concrete):

1. Rigid aluminum.
2. PVC Schedule 40.

E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors: PVC Schedule 40.

F. Direct Earth Burial: PVC Schedule 80.

G. Under Slabs-On-Grade: PVC Schedule 80.

H. Corrosive Areas, Exterior: PVC Schedule 80.

I. Corrosive Areas, Interior: PVC Schedule 80.

J. Conduits between VFD's and motors rigid aluminum (inside and outside).

K. Classified areas: rigid aluminum.

3.04 CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:

1. Conduit Size 4 Inches or Less: Flexible metal, liquid-tight conduit.
2. Conduit Size Over 4 Inches: Nonflexible.
3. Corrosive Areas: Flexible, nonmetallic, liquid or PVC-coated metallic, liquid-tight.
4. Length: 18-inch minimum, 60-inch maximum, of sufficient length to allow movement or adjustment of equipment.

B. Lighting Fixtures in Dry Areas: Flexible steel, non-liquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas required to be Oil-tight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Transition From Underground to Exposed: PVC Coated Rigid aluminum conduit unless restricted by code.

E. Under Equipment Mounting Pads: Rigid aluminum conduit.

F. Exterior Light Pole Foundations: Rigid aluminum conduit.

3.05 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Fire-stop openings around penetrations to maintain fire-resistance rating.

D. Apply single layer of wraparound duct band to all metallic conduit in contact with concrete floor slabs to a point 2 inches above concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide non-shrink grout dry-pack, or use watertight seal device.

F. Entering Structures:

1. General: Seal raceway at the first box or outlet with minimum 2 inches thick expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
2. Concrete Roof or Membrane Waterproofed Wall or Floor:

a. Provide a watertight seal.
b. Without Concrete Encasement: Install watertight entrance seal device on each side.
c. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
d. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.

3. Heating, Ventilating, and Air Conditioning Equipment:

a. Penetrate equipment in area established by manufacturer.
b. Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
c. Seal penetration with silicone type sealant as specified in Section 07270, FIRE STOPPING.

4. Corrosive-Sensitive Areas:
a. Seal all conduits passing through chlorine and ammonia room walls.
b. Seal all conduit entering equipment panel boards and field panels containing electronic equipment.
c. Seal penetration with silicone type sealant as specified in Section 07270, FIRE STOPPING.

5. Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device.

6. Non-waterproofed Wall or Floor (Underground, without Concrete Encasement):
a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
b. Fill space between raceway and sleeve with an expandable plastic compound on each side.

7. Manholes and Handholes:
a. Metallic Raceways: Provide insulated grounding bushings.
b. Nonmetallic Raceways: Provide bell ends flush with wall.
c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.06 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.

B. All supporting hardware shall be 316 stainless steel.

C. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 40 percent extra space for future conduit.

D. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

1. Wood: Wood screws.
2. Hollow Masonry Units: Toggle bolts.
3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
4. Steelwork: Machine screws.

E. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.07 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:

1. Bends 30-Degree and Larger: Provide factory-made elbows.
2. 90-Degree Bends: Provide PVC coated rigid aluminum elbows.
3. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.08 EXPANSION/DEFLECTION FITTINGS

A. Provide on all raceways at all structural expansion joints, and in long tangential runs.

B. Provide expansion/deflection joints for 50 degrees F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.09 PVC CONDUIT

A. Solvent Welding:

1. Provide manufacturer recommended solvent; apply to all joints.
2. Install such that joint is watertight.

B. Adapters:

1. PVC to Metallic Fittings: PVC terminal type.
2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

C. Belied-End Conduit: Bevel the un-belled end of the joint prior to joining.

3.10 PVC-COATED RIGID STEEL CONDUIT

A. Install in accordance with manufacturer's instructions.

B. Provide PVC boot to cover all exposed threading.

3.11 WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

3.12 CABLE TRAYS

A. Install in accordance with Application Information Section of NEMA VE 1.

B. Provide accessories as necessary for a complete system.

C. Install such that joints are not made at support brackets.

D. Install horizontal section support brackets between support point and quarter point of tray span.

E. Provide ceiling trapeze for all horizontal cable trays.

F. Install support within 2 feet on each side of expansion joints and within 2 feet of fitting extremity.

G. Provide expansion joints in accordance with NEMA VE 1 for 50 degrees F maximum temperature variation.

H. Install horizontal tray level, plumb, straight, and true to line or grade within a tolerance of 1/8 inch in 10 feet and within a cumulative maximum of 1/2 inch.

I. Install vertical tray plumb within a tolerance of 1/8 inch in 10 feet.

J. Install without exposed raw edges.

K. Maintain 9-inch vertical separation between multi-tiered trays having a common support, and at all crossover locations.

L. Provide bonding jumper at each expansion joint and adjustable connection.

M. Ground Conductor: Provide properly sized clamps for each section, elbow, tee, cross, and reducer.

3.13 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Provide manufacturer's pre-molded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Sheet Metal Boxes, Cabinets, and Enclosures:

1. Rigid Galvanized Conduit:
    a. Provide one lock nut each on inside and outside of enclosure.
    b. Install grounding bushing.
    c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
    d. Install insulated bushing on ends of conduit where grounding is not required.
    e. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
2. Electric Metallic Tubing: Provide gland compression, insulated connectors.
3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.

4. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.
5. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
6. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut.

C. Motor Control Center, Switchboard, Switchgear, and Free-Standing Enclosures: Terminate conduit-entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.

3.14 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Cover: Maintain minimum 2-foot cover above conduit, unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts.

D. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Spacers:

1. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench.
2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Installation with Other Piping Systems:

1. Crossings: Maintain minimum 12-inch vertical separation.
2. Parallel Runs: Maintain minimum 12-inch separation.
3. Installation over valves or couplings not permitted.

I. Install “Detectable Electric Warning Tape” for each underground ductbank, indicated or not on drawings.

J. Metallic Raceway Coating: At couplings and joints and along entire length, apply wraparound duct band with one-half tape width overlap to obtain two complete layers.

J. Backfill:

1. As specified in Section 02225, TRENCH BACKFILL.
2. Do not backfill until inspected by ENGINEER.

3.15 MANHOLES AND HANDHOLES

A. Excavate, shore, brace, backfill, and final grade in accordance with Section 02205, EXCAVATION, and Section 02225, TRENCH BACKFILL.

B. Do not install until final raceway grading has been determined.

C. Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.

D. Grounding: As specified in Section 16450, GROUNDING.

E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers shall be 1-inch minimum height.

3.16 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull-tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Paragraph IDENTIFICATION DEVICES, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.17 IDENTIFICATION DEVICES

A. Raceway Tags:

1. Identify origin and destination.
2. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed Raceway, whether in ceiling space or surface mounted.
3. Provide nylon strap for attachment.

B. Detectable Electric Warning Tape: Install approximately 12 inches above underground raceways. Align parallel to, and within 12 inches of, centerline of runs, including fiber optic conduits.

C. Buried Raceway Markers:

1. Install at grade to indicate direction of underground raceways.
2. Install at all bends and at intervals not exceeding 100 feet in straight runs.

3.18 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

D. Touch up damage to coating on PVC-coated conduit with patching compound approved by manufacturer.

END OF SECTION

SECTION 16120

CONDUCTORS

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American National Standards Institute (ANSI): 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
2. American Society for Testing and Materials (ASTM):
   a. A167, Standard Specification for Stainless and Heat Resisting Chromium-Nickel-P1ated Steel Plate, Sheet, and Strip.
   b. B3, Standard Specification for Soft or Annealed Copper Wire.
   c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   d. B263, Standard Test Method for Determination of Cross- Sectional Area of Stranded Conductors.
3. Association of Edison Illuminating Companies (AEIC):
   a. CS 5, Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 Through 35 kV.
   b. CS 6, Ethylene- Propylene-Rubber-Insulated Shielded Power Cables Rated 5 Through 69 kV.
4. Insulated Cable Engineer's Association, Inc. (ICEA): T-29-250, Procedure for Conducting Vertical Cable Tray Flame Test With a Theoretical Heat Input of 210,000 Btu/hour.
5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 48, Standard Test Procedures and Requirements or High-Voltage Alternating Current Cable Terminations.
   b. 404, Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000V through 46,000V and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500V through 500,000V.
6. National Electrical Contractors Association, Inc. (NECA): 5055, Standard of Installation.
7. National Electrical Manufacturers' Association (NEMA):
   a. CC 1, Electric Power Connectors for Substations.
   b. WC 3, Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
   c. WC 5, Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

d. WC 7, Crosslinked-Thermosetting-Polyethylene-lnsulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
e. WC 8, Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
f. WC 55, Instrumentation Cables and Thermocouple Wire.

8. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
9. Underwriters Laboratories, Inc. (UL):
   a. 13, Standard for Safety Power-Limited Circuit Cables.
   b. 44, Standard for Safety Rubber-Insulated Wires and Cables.
   c. 62, Standard for Safety Flexible Cord and Fixture Wire.
   d. 486A, Standard for Safety Wire Connector and Soldering Lugs for Use with Copper Conductors.
   e. 486B, Standard for Safety Wire Connectors and Soldering Lugs for Use with Aluminum Conductors.
   f. 510, Standard for Safety Insulating Tape.
   g. 854, Standard for Safety Service-Entrance Cables.
   h. 910, Standard for Safety Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air Handling Spaces.
   i. 1072, Standard for Safety Medium-Voltage Power Cables.
   j. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
   k. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Shop Drawings:

1. Wire and cable descriptive product information.
2. Wire and cable accessories descriptive product information.
3. Cable fault detection system descriptive product information.
4. Manufactured wiring systems descriptive product information.
5. Manufactured wire systems rating information.
6. Manufactured wire systems dimensional drawings.
7. Manufactured wire systems special fittings.
8. Busway descriptive product information.
9. Busway rating information.
10. Busway dimensional drawings.
11. Busway special fitting information.
12. Busway-equipment interface information for equipment to be connected to busways.

B. Quality Control Submittals:

1. Certified Factory Test Report for conductors 600 volts and below.
2. Certified Factory Test Report per AEIC CS6, including AEIC qualification report for conductors above 600 volts.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 - PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 3, WC 5, and WC 7.

B. Conductor Type:

3. All Circuits: Stranded copper.

C. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW insulation.

D. Direct Burial and Aerial Conductors and Cables:

1. Type USE/RHH/RHW insulation, UL 54 listed, Type RHW-2/USE-2.
2. Conform to physical and minimum thickness requirements of NEMA WC 3.

E. Flexible Cords and Cables:

1. Type SOW-A50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 8.

F. Cable Tray Conductors and Cables: Type TC.

2.02 600-VOLT RATED CABLE

A. General:

1. Type: TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu/hr, and NFPA 70, Article 340, or UL 13 Listed Power Limited Circuit Cable meeting requirements of NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. CABLE Type "A", Wire and Connectors

1. Cable shall be rated for 600 volts and shall meet the requirements below:
2. Conductors shall be stranded
3. All wire shall be brought to the job in unbroken packages and shall bear the data of manufacturing; not older than 12 months.
4. Type of wire shall be XHHW or THHN, rated 75 degrees C suitable for wet locations except where required otherwise by the drawings.
5. No wire smaller than No. 12 gauge shall be used unless specifically indicated.
6. Conductor metal shall be copper.
7. All conductors shall be megger tested after installation and insulation must be in compliance with the Insulated Power Cable Engineers Association Minimum Values of Insulation Resistance.

C. Type l-Multiconductor Control Cable:

1. Conductors:
   a. No. 14 AWG, seven-strand copper.
   b. Insulation: 15-mil PVC with 4-mil nylon.
   c. UL 1581 listed as Type THHN/THWN rated VW-I.
   d. Conductor group bound with spiral wrap of barrier tape.
   e. Color Code: In accordance with NEMA WC 5, Method 1, and Sequence K-2.
2. Cable: Passes the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.

3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (inches)	Jacket Thickness (mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	00.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
   a. Okonite Co.
   b. Rome Cable.

D. Type 2-Multiconductor Power Cable:

1. Conductors:
   a. Class B stranded, coated copper.
   b. Insulation: Chemically crosslinked ethylene-propylene with Hypalon jacket.
   c. UL 1581 listed as Type EPR, rated VW-1.
   d. Color Code: Conductors, size No. 8 AWG and smaller, colored conductors, NEMA WC5 Method 1, color 5 per Article POWER CONDUCTOR COLOR CODING. Conductors, size No. 6 AWG and larger, NEMA WC5, Method 4.
2. Cable passes the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.
3. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	No. Of Conductors	Max.Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
12	12	2 3 4	0.42 0.45 0.49	45 45 45
10	10	2 3 4	0.54 0.58 0.63	60 60 60
8	10	3 4	0.66 0.72	60
6	8	3 4	0.74 0.81	60

4	6	3 4	0.88 0.97	60 80
2	6	3 4	1.01 1.11	80
1/0	6	3 4	1.22 1.35	80
2/0	4	3 4	1.32 1.46	80
4/0	4	3 4	1.56 1.78	80

4. Manufacturers:
   a. Okonite Co.
   b. Pome Cable.

E. Type B-No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.

1. Outer Jacket: 45-mil nominal thickness.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
3. Dimension: 0.31-inch nominal OD.
4. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8
   b. 20 AWG, seven-strand tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nominal nylon.
   e. Color Code: Pair conductors black and red.
5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
6. The following test shall be performed on instrumentation and control system cables. All tests shall be end-to-end test of installed cables with the ends supported in free air, not adjacent to any ground object. All test data shall be recorded on forms acceptable to the Engineer. Complete records of all tests shall be made and delivered to the Engineer.
   a. Continuity tests shall be performed by measuring wire/shield loop resistances of signal cable as the wires, taken one at a time, are shorted to the channel shield. No loop resistance measurement shall carry by more than $\pm$2 ohms from the calculated average loop resistance valve.
   b. Insulation resistance tests shall be performed by using a 500 volt megohmeter to measure the insulation resistance between each

channel wire and channel shield, between individual channel shields in a multi-channel cable, between each individual channel and the overall cable shield in multi-channel cable, between each wire and ground, and between each shield and ground. Values of resistance less than 10 megohms shall be unacceptable.

F. Type B1-No. 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.

1. Outer Jacket: 45-mil nominal.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
3. Dimension: 0.32-inch nominal OD.
4. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
   b. 20 AWG, seven-strand, tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nylon.
   e. Color Code: Triad conductors black, red, and blue.
5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.

G. Type B2-No. 18 AWG, Multi-Twisted, Shielded Pairs with a Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 55 requirements.

1. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8
   b. Tinned copper drain wires.
   c. Pair drain wire size AWG 20, group drain wire size AWG 18.
   d. Insulation: 15-mil PVC.
   e. Jacket: 4-mil nylon.
   f. Color Code: Pair conductors black and red with red conductor numerically printed for group identification.
   g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.
2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.

3. Cable Sizes:

Number Of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
4	0.50	45
8	0.68	60
12	0.82	60
16	0.95	80
24	1.16	80
36	1.33	80
50	1.56	80

4. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.

H. Type B3-No. 18 AWG, Multi-twisted Pairs with a Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable meeting NEMA WC 55.

1. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
   b. Tinned copper drain wire size 18 AWG
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nylon.
   e. Color Code: Pair conductors black and red, with red conductor numerically printed for group identification.
2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
3. Cable Sizes:

Number Of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
4	0.46	45
8	0.63	60
12	0.75	60
16	0.83	60
24	1.06	80
36	1.21	80
50	1.42	80

4. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Or approved Equal.

I. RTD Type Cable:
   1. Coordinate with pump supplier for the actual RTD type (2-wire or 3-wire type) supplied with the motor and supplier recommended RTD type cable and provide accordingly.

   2. Manufacturers:
      a. Belden, or
      b. Approved Equal.

J. Ethernet Cat. 6 UTP Cable (Copper):
   1. Section applies to all Ethernet Cable (Copper) except for Fiber Optic cable.
   2. Conductor Physical Characteristics: 4 twisted pairs (8 conductors), 23 AWG solid bare Copper with Polyolefin Insulation. Overall Nominal Diameter: 0.235 inch. Operating Temperature Range: -20 degrees C to +75 degrees C. Model Number – 7881A, Belden Inc.
   3. NEC/UL specification CMR, CMP, CMX, UL444, UL verified category 6. For underground installation, provide wet location rated cable. For cable tray installation, provide TC rated cable. If cables is routed underground for some portion and cable tray for some portion, the Ethernet cable shall be both underground and cable tray rated.
   4. Manufacturer:
      a. Belden Inc.
      b. Mohawk.
      c. Or approved equal.

2.03 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.04 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arcs and Fireproofing:
   a. 30-mil, elastomer
   b. Manufacturers and Products:
      1) Scotch; Brand 77, with Scotch Brand 69 glass cloth tape binder.
      2) Plytnount; Plyarc 30, with Plymount Plyglas glass cloth tape binder.

B. Identification Devices:

1. Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.
2. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
3. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO.
2. Nylon Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO.

D. Cable Lugs:

1. In accordance with NEMA CC I.
2. Rated 600 volts of same material as conductor metal.
3. Insulated, Locking-Fork, Compression Lugs:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) ILSCO; ILSCONS.

4. Un-insulated Crimp Connectors and Terminators:
   a. Manufacturers and Products:
      1) Square D; Versitide.
      2) Thomas & Betts; Color-Keyed.
      3) ILSCO.
5. Un-insulated, Bolted, Two-Way Connectors and Terminators:
   a. Manufacturers and Products:
      1) Thomas & Betts; Locktite.
      2) Burndy; Quiklug.
      3) ILSCO.

E. Cable Ties: Nylon, adjustable, self-locking, and reusable.

1. Manufacturers and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation: Thermally stabilized, crosslinked polyofin.

1. Manufacturers and Product: Thomas & Betts; SHRINK-KON.

2.05 PULLING COMPOUND

A. Nontoxic, non-corrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

D. Manufacturers and Products:

1. Ideal Co.; Yellow 77.
2. Polywater, Inc.
3. Cable Grip Co.

2.06 BUSWAY

A. Low impedance, copper bus bar, outdoor copper-free 1/8-inch extruded aluminum housing with full neutral (where specified) and internal ground bus, totally enclosed non-ventilated and joint insulation of polyester film.

B. UL listed for support and spacing provided, meeting NFPA 70 requirements, NEMA BU-1, UL B57, ANSI C37.23, and totally enclosed throughout its length.

C. Suitable for mounting in vertical (edgewise) or horizontal position without derating, and capable of withstanding short-circuit of 100,000 amperes symmetrical.

D. Provide expansion fitting when the bus crosses a building expansion joint.

E. Provide integral weather seal on all outdoor entrance points.

F. Provide flanged ends or end cable tap box on all indoor end points.

G. Manufactured by Square D, Model I-Line II, or approved equal.

2.07 WARNING TAPE

A. As specified in Section 16110, RACEWAYS.

2.08 SOURCE QUALITY CONTROL

A. Conductors 600-Volts and Below: Test in accordance with UL 44 and 854 Standards.

PART 3 - EXECUTION

3.01 GENERAL

A. Conductor installation to be in accordance with NECA 5055.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.

E. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

F. Bundling: Where single conductors and cables in manholes, hand holes, vaults, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

H. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4-inch smaller than raceway inside diameter.

I. Cable Tray Installation:

1. Install wire and cable parallel and straight in tray.
2. Bundle, in groups, all wire and cable of same voltage having a common routing and destination; use cable ties, at maximum intervals of 8 feet.
3. Clamp cable bundles prior to making end termination connections.
4. Separate cables of different voltage rating in same cable tray with barriers.
5. Fasten wires, cables, and bundles to tray with nylon cable straps at the following maximum intervals:
   a. Horizontal Runs: 20 feet.
   b. Vertical Runs: 5 feet.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.
2. No. 8 AWG and Smaller: Provide colored conductors.
3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A	Gray Brown

	Phase B Phase C	Orange Yellow
NOTE: Phase A, B, C implies direction of positive phase rotation		

4. Tracer: Outer covering of white with an identifiable colored strip other than green in accordance with NFPA 70.

3.03 CIRCUIT IDENTIFICATION

A. Circuits Appearing in Circuit Schedules: identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, hand holes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:

1. Assign circuit name based on device or equipment at load end of circuit.
2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

C. Method:

1. Conductors No. 3 AWG and Smaller: Identify with sleeves.
2. Cables, and Conductors No. 2 AWG and Larger:
   a. Identify with marker plates.
   b. Attach marker plates with nylon tie cord.
3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors No. 6 AWG and larger unless specifically indicated or approved by ENGINEER.

C. Connections and Terminations:

1. Install wire nuts only on solid conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 6 AWG and smaller.

3. Install un-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.
4. Install un-insulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.
5. Install un-insulated bolted two-way connectors for motor circuit conductors No. 12 and larger.
6. Tape insulates all un-insulated connections.
7. Place no more than one conductor in any single-barrel pressure connection.
8. Install crimp connectors with tools approved by connector manufacturer.
9. Install terminals and connectors acceptable for type of material used.
10. Compression Lugs
    a. Attach with a tool specifically designed for purpose.
    b. Tool shall provide complete controlled crimp and shall not release until crimp is complete.
    c. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:

1. Indoors: Use general purpose, flame retardant tape.
2. Outdoors: Use flame retardant, cold- and weather-resistant tape.

F. Cap spare conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:

1. Remove surplus wire, bridle and secure.
2. Where conductors pass through openings or over edges in sheet metal, remove bums, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
4. Where connections of cables installed under this section are to be made under Section 13400, PROCESS INSTRUMENTATION AND

CONTROL SYSTEMS (PICS), leave pigtails of adequate length for bundled connections.

5. Cable Protection:
    a. Under Infinite Access Floors: May be installed without bundling.
    b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under the floor or grouped into bundles at least 1/2-inch in diameter.
    c. Maintain integrity of shielding of instrumentation cables.
    d. Ensure grounds do not occur because of damage to jacket over the shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.05 FIELD QUALTTY CONTROL

A. In accordance Section 16950, ELECTRICAL TESTING.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American National Standards Institute (ANSI): C2, National Electrical Safety Code (NESC).
2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.02 SUBMITTALS

A. Shop Drawings:

1. Product Data:
   a. Exothermic weld connectors.
   b. Mechanical connectors.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 - PRODUCTS

2.01 GROUND ROD

A. Material: Copper clad.

B. Diameter: Minimum 5/8 inch.

C. Length: 30 feet.

2.02 GROUND CONDUCTORS

A. As specified in Section 16120, CONDUCTORS.

2.03 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Utilize low-smoke, low-emission process.
3. Manufacturers:
   a. Erico Products, Inc.; Cadweld amd Cadweld Exolon.
   b. Thermoweld.

B. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

1. Manufacturers:
   a. Burndy Corp.
   b. Thomas and Betts Co.

2.04 GROUNDING WELLS

A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

B. Manufacturers:

1. Christy Co.; No. G5.
2. Lightning and Grounding Systems, Inc.; I-R Series.

PART 3 - EXECUTION

3.01 GENERAL

A. Grounding shall be in compliance with NFPA 70 and ANSI C2.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed non-current-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

E. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

F. Shielded Control Cables:

1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum I inch at termination to field instrument and apply heat shrink tube.
3. Do not ground control cable shield at more than one point.

G. Mechanical type connections will be allowed in applications where exothermic type connections are not practical.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to non current-carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.03 MOTOR GROUNDING

A. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to non current-carrying grounding bus.

3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

3.05 GROUNDING WELLS

A. Install inside buildings, asphalt, and paved areas.

B. Install riser ring and cover flush with surface.

C. Place 9 inches crushed rock in bottom of each well.

3.06 CONNECTIONS

A. General:

1. Above grade Connections: Use either exothermic weld or mechanical-type connectors; or brazing.
2. Below grade Connections: Install exothermic weld connectors unless otherwise noted.
3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
4. Notify ENGINEER prior to backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.
2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.07 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.08 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each.

B. Ground Rod Floor Protrusion: 4 to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all non current-carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 6 AWG copper conductor.

3.09 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.

B. Bond neutrals of substation transformers to substation grounding grid and system grounding network.

C. Bond neutrals of pad-mounted transformers to four locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.10 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

3.11 INSTRUMENT GROUND - SURGE SUPPRESSION

A. Connect all instrument surge protection with #6 insulated copper groundwire (in conduit where above grade) to closest plant ground system

3.12 BONDING

A. Bond to Main Conductor System:

1. All roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.
2. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.

3. Provide air terminals as required.

B. Bond steel columns or major framing members to grounding system per National Electrical Code.

C. Bond each main down conductor to grounding system.

3.13 GROUNDING SYSTEM

A. Grounding Conductor (Counterpoise):

1. Completely encircle building structure.
2. Bury minimum 30” below finished grade.
3. Minimum 2 feet distance from foundation walls.

B. Interconnect ground rods by direct-buried copper cables.

C. Connections:

1. Install ground cables continuous between connections.
2. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and nonaccessible connections.
3. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
4. Use bolded offset parapet bases or through-roof concealed base assemblies for air terminal connections.
5. Provide interconnections with electrical and telephone systems.
6. Provide electric service arrestor ground wire to building water main.

3.14 FIELD QUALITY CONTROL

A. As specified in Section 16950, ELECTRICAL TESTING.
B. Ground test shall be witnessed by the County and shall be measured 5 ohms or less.

END OF SECTION

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment(1,000 Volts Maximum).
2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
3. Uniform Building Code (UBC): Section 2329, Earthquake Requirements.
4. Underwriters Laboratories, Inc. (UL):
   a. 595, Standard for Safety Marine-Type Electric Lighting Fixtures.
   b. 844, Standard for Safety Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.
   c. 924, Standard for Safety Emergency Lighting and Power Equipment.

1.02 SUBMITTALS

A. Shop Drawings:

1. Interior Luminaires:
   a. Catalog data sheets and pictures.
   b. Luminaire finish and metal gauge.
   c. Lens material, pattern, and thickness.
   d. Candle power distribution curves in two or more planes.
   e. Candle power chart 0 to 90 degrees.
   f. Lumen output chart.
   g. Average maximum brightness data in foot lamberts.
   h. Coefficients of utilization for zonal cavity calculations.
   i. Mounting or suspension details.
   j. Heat exchange and air handling data.
2. Exterior Luminaires:
   a. Catalog data sheets and pictures.
   b. Luminaire finish and metal gauge.
   c. Lens material, pattern, and thickness.
   d. IES lighting classification and isolux diagram.
   e. Fastening details to wall or pole.
   f. Ballast type, location, and method of fastening.

g. For light poles, submit wind loading, complete dimensions, and finish.

3. Lamps:
   a. Voltages.
   b. Colors.
   c. Approximate life (in hours).
   d. Approximate initial lumens.
   e. Lumen maintenance curve.
   f. Lamp type and base.
   g. Copy of lamp order, including individual quantities, for Project.
4. Ballasts:
   a. Type.
   b. Wiring diagram.
   c. Nominal watts and input watts.
   d. Input voltage and power factor.
   e. Starting current, line current, and restrike current values.
   f. Sound rating.
   g. Temperature rating.
   h. Efficiency ratings.
   i. Low temperature characteristics.
   j. Emergency ballasts rating and capacity data.
5. Photo-Time Control:
   a. Wiring diagram.
   b. Contact ratings.
6. Photocells:
   a. Voltage, and power consumption.
   b. Capacity.
   c. Contacts and time delay.
   d. Operating levels.
   e. Enclosure type and dimensions.
   f. Temperature range.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

1.04 SPARE PARTS

A. Provide one spare light fixtures for each type used. See Electrical drawings for light fixture/luminaire schedule.

PART 2 - PRODUCTS

2.01 LUMINAIRES

A. Specific requirements relative to execution of Work of this section is located in the Luminaire Schedule on Drawings.

B. Feed-through type, or separate junction box.

C. Ballasts: Two-lamp when possible.

D. Tandem wired for three-lamp, fluorescent fixtures.

E. Wire Leads: Minimum 18 AWG.

F. Component Access: Accessible and replaceable without removing luminaire from ceiling.

G. Soffit Installations:

1. UL Labeled: SUITABLE FOR DAMP LOCATIONS.
2. Ballast: Removable, prewired.

H. Exterior Installations:

1. UL Labeled: SUITABLE FOR WET LOCATIONS.
2. Ballast: Removable, prewired.
3. When factory-installed photocells are provided, entire assembly shall have UL label.

I. Emergency Lighting:

1. Power Pack: Self-contained, 120-volt transformer, inverter/charger, sealed nickel cadmium battery, and indicator switch in accordance with UL 924.
2. Lighted, push-to-test indicator.
3. Capable of providing full illumination for 1-1/2 hours in emergency mode.
4. Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.
5. Capable of protecting against excess charging and discharging.

2.02 LAMPS

A. LED:

1. Type Efficiency: Energy.
2. Color: Soft white (3500K or 4000K).

B. Manufacturers:

1. General Electric.
2. Sylvania.
3. North American Phillips.
4. Or equal.

2.03 BALLASTS

A. General:

1. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
2. Certified by electrical testing laboratories to conform to Certified Ballast Manufacturer's specifications.

B. LED:

1. LED fixture driver shall be as per the LED light fixture manufacturer’s recommendation if not otherwise noted on the drawings.
2. LED driver shall be fixed or dimmable version, as noted on the drawings.

2.04 LIGHTING CONTROL

A. Photocell for lighting contactor:

1. Automatic ON/OFF switching photo control.
2. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.
3. Setting: ON at dusk and OFF at dawn.
4. Time delay feature to prevent false switching.
5. Field adjustable to control operating levels.
6. Manufacturers:
    a. Tork.
    b. Paragon.

2.05 POLES

A. Rating (with Luminaire): All pole installation shall be suitable for 140 mph wind with appropriate gust factor per applicable zone of installation as defined in the Florida Building Code. The contractor shall include with the shop drawing submittal, a pole wind loading calculation signed and sealed by a structural engineer registered in Florida showing that the proposed installations will meet the given wind loading requirement.

B. Material: Extruded aluminum or concrete.

2.06 EMERGENCY BALLAST

A. In accordance with UL 924.

B. Nickel cadmium battery, charger, and electronic circuitry in metal case plus ac ballast.

C. Solid state charging indicator monitoring light and double-pole test switch.

D. Capable of operating one fluorescent lamps for a period of 90 minutes with output of 1,100 to 1,200 lumens.

E. Manufacturers:

1. MagneTec Jefferson.
2. Bodine.
3. Radiant.

PART 3 - EXECUTION

3.01 LUMINAIRES

A. General:

1. Install in accordance with manufacturer's recommendations.
2. Provide proper hangers, pendants, and canopies as necessary for complete installation.
3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building and to concrete pole bases required to safely mount.
4. Install plumb and level.
5. Mounting heights shown for wall mounted or pendant mounted luminaires are measured from bottom of luminaire to finished floor or finished grade, whichever is applicable.
6. Install each luminaire outlet box with galvanized stud.

B. Pendant Mounted:

1. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
2. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart.
3. Provide twin-stem hangers on single luminaires.

C. Pole Mounted:

1. Provide precast concrete base.
2. Provide branch circuit in-line fuses in pole base handhole.

D. Swinging Type:

1. Provide, at each support, safety cable capable of supporting four times the vertical load from the structure to the luminaire.

E. Finished Areas:

1. Install symmetrically with tile pattern.
2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.

4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use fixtures suitable for mounting on low density ceilings.
5. Junction Boxes:
    a. Flush and Recessed Luminaires: Locate minimum 1 foot from luminaire.
    b. In concealed locations, installjunction boxes to be accessible by removing luminaire.
6. Wiring and Conduit:
    a. Provide wiring of temperature rating required by luminaire.
    b. Provide flexible steel conduit.
7. Provide plaster frames when required by ceiling construction.
8. Independent Supports:
    a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft-annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.
    b. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.
    c. Fasten chain or wire to each end of luminaire.

F. Unfinished Areas: Locate luminaires to avoid either conflict with other building systems or blockage of luminaire light output.

1. Fixture Suspension: Provide 1/4-inch threaded steel hanger rods. Scissor type hangers not permitted.
2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

3.02 LAMPS

A. Provide in each fixture, the number and type for which the fixture is designed, unless otherwise noted.

3.03 BALLASTS

A. Install in accordance with manufacturer's recommendations.

B. Utilize all ballast mounting holes to fasten securely within luminaire.

C. Replace noisy or defective ballasts.

3.04 LIGHTING CONTROL

A. Outdoor Luminaires: Photocells switch lights ON at dusk and OFF at dawn.

3.05 EMERGENCY BALLAST

A. Install battery, charger, and electronic circuitry metal case inside fluorescent fixture housing adjacent to ac ballast.

B. Install monitoring light and double-pole switch adjacent to light fixture.

C. Wire in accordance with manufacturer's wiring diagrams.

3.06 CLEANING FOLLOWING CONSTRUCTION

A. Remove all labels and other markings, except UL listing mark.

B. Wipe luminaires inside and out to remove construction dust.

C. Clean luminaire plastic lenses with antistatic cleaners only.

D. Touch up all painted surfaces of luminaires and poles with matching paint ordered from manufacturer.

E. Replace all defective lamps at time of Substantial Completion.

END OF SECTION

SECTION 16722

FIRE ALARM SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish, test, install, and place in satisfactory operation a complete, addressable, microprocessor based fire detection and alarm system consisting of manual and automatic initiating devices, notification appliances, control panel, surge suppression, line isolators and all spare parts, accessories and appurtenances as herein specified and as shown on the Drawings. System shall electrically supervise all wires, including fiber optic cables, and both the alarm initiating devices and the audible and visual alarm devices. Contractor shall document the fire alarm monitoring & installation and transfer the documents to the Owner after testing.

B. System is local only but central station monitoring will be required.

C. Fire alarm system is designed around manufacturer **Silent Knight**. Existing fire alarm system at Operations Building is Silent Knight and new fire alarm system at Maintenance Building shall match the same manufacture and model so that it can be a slave panel to the existing fire alarm system. Furnish and install all necessary communication module, media converter and make all necessary programming modifications so that new fire alarm panel at Maintenance Building can communication with the main fire alarm panel at Operations Building.

D. Fire alarm system shall meet the following criteria:

1. System shall be power limited.
2. Secondary power shall be supplied by 24V DC batteries with capacity for 24 hours of continuous standby operation followed by 5 minutes of operation in alarm condition.
3. Sub-Panels, including NAC power panels, shall communicate over Class A, Style 7 circuits.
4. Maximum voltage drop on 24V DC NAC circuits shall not exceed the lowest rated voltage of all connected devices on that circuit.
5. Maximum voltage drop on 24V DC SLC circuits shall not exceed the lowest rated voltage of all connected devices on that circuit.
6. Device locations and mounting heights shall be in accordance with ADA requirements.
7. All flashing strobe or horn/strobe notification appliances located within the same area that can be seen in a 135° field of view and are

within 55 feet of the next strobe or horn strobe shall be synchronized.

E. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

F. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

G. The CONTRACTOR shall employ NICET (minimum Level II Fire Alarm Technology) technicians for installation on site and to guide the final checkout and to ensure the systems integrity.

H. Contractor also shall provide 1-year pre-paid service contract with Central Monitoring Services as part of this project for both fire alarm system and security alarm system. Fire alarm and Security alarm system are shown on drawings F-series and specifications 16722 and 16730.

I. All necessary raceway/conduits and junction boxes shall be supplied by the Electrical Contractor. Fire Alarm System shall be installed under the supervision of the Electrical Contractor so that no additional low voltage permit is needed. Coordinate with Electrical Contractor to meet all requirements to fall under the Electrical Contractor's low voltage permit before bidding. If Fire Alarm System Supplier does not meet the requirements to fall under the Electrical Contractor's low voltage permit, he/she shall supply additional permit as needed with no additional cost to the Owner.

1.02 RELATED SECTIONS

A. Section 16010 - Electrical General Requirements

B. Section 16050 - Basic Electrical Materials and Methods

1.03 REFERENCES

A. This section contains references to the following documents. They are part of this section as specified and modified. In situations of conflict between the requirements of his section and those of the listed documents, the requirements of this section shall prevail.

1. Florida Handicap Accessibility Code – Latest Edition.
2. UL – Underwriters Laboratories
3. NFPA 70 - National Electrical Code (NEC).
4. NFPA 72 - National Fire Alarm Code.

5. NFPA 101 - Life Safety Code.
6. UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
7. UL 268A – Smoke Detectors for Duct Applications.
8. UL 521 - Heat Detectors for Fire Protective Signaling Systems.
9. UL 864 - Control Units for Fire Protective Signaling Systems.
10. UL 1971 – Visual Notification Appliances.
11. UL 464 - Audible Signaling Appliances.
12. UL 38 - Manually Actuated Signaling Boxes
13. UL 1481 - Power Supplies for Fire Protective Signaling Systems
14. Florida Building Code
15. All Local Fire Codes.
16. All requirements of the Authority Having Jurisdiction (AHJ).

1.04 WORK INCLUDED

A. Provide all materials, equipment, labor, supervision and all related items necessary to complete this phase of the work as indicated on the drawings and specifications, including fire alarm control panel, fire alarm annunciator panel, manual stations, detectors, signal appliances and all other devices as required. Supply and install all conduits and wiring as required. The fire alarm system shall be complete and operable as required by the local Fire Marshall and state inspector.

1.05 DEFINITIONS

A. Alarm-Initiating Device: A manual station, smoke detector, heat detector, flame detector, or sprinkler water-flow switch.

B. Alarm Signal: Signifies a state of emergency requiring immediate action. Pertains to signals such as the operation of an alarm-initiating device.

C. Class A Wiring: Circuits arranged and electrically supervised so a single break or single ground fault condition will be indicated by a trouble signal at the fire alarm control panel (FACP) and the circuit will continue to be capable of operation for its intended service in the faulted condition no matter where the break or ground fault condition occurs.

D. Multiplex System: One using signaling method characterized by the simultaneous or sequential transmission, or both, and the reception of multiple signals in a communication channel, including means for positively identifying each signal.

E. Notification Appliance: Audio and/or visual indicating device such as a strobe or horn/strobe.

F. Supervisory Signal: Indicates abnormal status or need for action regarding fire suppression or other protective system.

G. Trouble Signal: Indicates that a fault, such as an open circuit or ground, has occurred in the system.

H. SPD: Surge Protection Device (Transient Voltage Surge Suppression)

1.06 SYSTEM DESCRIPTION

A. Signal Transmission: Multiplex signal transmission dedicated to fire alarm service only.

B. Functional Description: The following are required system functions and operating features:

1. Priority of Signals: Accomplish automatic response functions by the first device initiated. Alarm functions resulting from initiation by the first device are not altered by subsequent alarms. The highest priority is an alarm signal. Supervisory and trouble signals have second- and third-level priority. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all alarm signals regardless of priority or order received.
2. Non-interfering: Design, power, wire, and supervise the system so a signal one device does not prevent the receipt of signals from any other device. All alarms are manually resettable from the FACP after the initiating device or devices are restored to normal. Systems that require the use of batteries or battery backup for the programming function are not acceptable.
3. Signal Initiation: The manual or automatic operation of an alarm-initiating or supervisory-operating device causes the FACP to activate all audible and visual alarm devices. The signals shall include, but not be limited to, the following:
   a. General alarm.
   b. Smoke detector alarm.
   c. Elevator recall.
   d. System trouble.
   e. Fan shutdown.
4. Silencing at FACP: Keypad provides capability for acknowledgment of alarms; supervisory, trouble, and other specified signals at the FACP; and capability to silence the local audible signal. Subsequent alarms cause the audible signal to sound again until silenced in turn by keypad operation.
5. A single ground or open on any system signaling line circuit, initiating device circuit or notification appliance circuit shall not

cause system malfunction, loss of operating power or the ability to report an alarm.

6. Loss of primary power at the FACP sounds trouble signal at the FACP. An emergency power light is illuminated at both locations when the system is operating on an alternate power supply.
7. Annunciation: Manual and automatic operation of alarm- and supervisory-initiating devices is annunciated on the FACP indicating the location and type device.
8. General Alarm: A system general alarm includes:
    a. Indicating the general alarm condition at the FACP.
    b. Identifying the device that is the source of the alarm at the FACP and the annunciator.
    c. Initiating audible and visible alarm signals throughout the building.
    d. Initiating elevators' automatic recall operation.
    e. Stopping supply and return fans serving zone where alarm is initiated.
    f. Recording the event on the system printer.
9. Manual station alarm operation initiates a general alarm.
10. Smoke detection initiates a general alarm.
11. Heat detection initiates a general alarm.
12. Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.
13. Remote Detector Sensitivity Adjustment: Manipulation of controls at the FACP causes the selection of specific addressable smoke detectors for adjustment, display of their current status and sensitivity settings, and control of changes in those settings. The same controls can be used to program repetitive, scheduled, automated changes in sensitivity of specific detectors.
14. Digitized electronic signals shall employ check digits or multiple polling.
15. Any device in the system may be enabled or disabled through the system keypad. Any system output may be turned on or off from the system keypad.
16. Addressable devices shall provide an address-setting means using rotary decimal switches.
17. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on a loop. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the loop. If a wire-to-wire short occurs, the isolator module shall automatically disconnect the loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section. The isolator module shall not require any address setting, and its operations shall be

totally automatic. It shall not be necessary to replace or reset an isolator module after normal operation.

C. Recording of Events: Record all alarm, supervisory, and trouble events. Records are by device, and function. When the FACP receives a signal, the alarm, supervisory, and trouble conditions are stored. The record shall include the type of signal (alarm, supervisory, or trouble) the device address, date, and the time of the occurrence. The record differentiates alarm signals from all other printed, indications. When the system is reset, this event is also recorded, including the same information concerning device, location, date, and time. A command initiates the listing of existing alarm, supervisory, and trouble conditions in the system.

1. Permissible Signal Time Elapse: The maximum permissible elapsed time between the actuation of any fire alarm or fire-detection system alarm-initiating device and its indication at the FACP is ten seconds.
2. Independent System Monitoring: Supervise each independent smoke detection system, duct detector, and elevator smoke detection system for both normal operation and trouble.
3. Circuit Supervision: Indicate circuit faults by means of both a zone and a trouble signal at the FACP. Provide a distinctive indicating audible tone and (LED) indicating light. The maximum elapsed time between the occurrence of the trouble condition and its indication at the FACP is 200 seconds

1.07 SUBMITTALS

A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.

1. Eight copies of all submittals shall be submitted to the Architect/Engineer for review. Shop drawings shall mirror design drawings for design and technical data, but not necessarily in appearance.
2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality.
3. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.
4. For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.
5. Product data for system components. Include dimensioned plans and elevations showing minimum clearances and installed features and devices. Include list of materials and NRTL-listing data.

6. Wiring diagrams from manufacturer differentiating between factory- and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Indicate components for both field and factory wiring.
7. System operation description covering this specific Project including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
8. Operating instructions for mounting at the FACP.
9. Operation and maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1. Include data for each type product, including all features and operating sequences, both automatic and manual. Include recommendations for spare parts to be stocked at the site. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.
10. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
11. Record of field tests of system.

1.08 QUALITY ASSURANCE

A. The fire alarm system shall comply with the applicable provisions of the NFPA Standard 72 “National Fire Alarm Code” and meet all the requirements of NEC 760. All equipment and devices shall be listed by the Underwriters' Laboratories or approved by the Factory Mutual Laboratories.

B. Installation shall meet Class A requirements. Fire alarm system shall require supervision of installation by authorized factory representative or agency.

C. After installation, the fire alarm system shall be balanced, checked, tested, operated and certified in writing as operational by factory representative or agency. Test each smoke and heat detector individually for operation.

D. Testing shall be performed in the presence of the plant chief operator and Fire Marshall, or his designated assistant.

E. Contractor shall obtain a written approval of the installed fire alarm system from the Fire Chief and send one (1) copy to the Owner and one (1) copy to the Engineer.

F. Installer Qualifications: A certified or qualified Installer is to perform the Work of this Section.

G. Compliance With Local Requirements: Comply with the applicable building code, local ordinances, and regulations, and the requirements of the authority having jurisdiction.

H. Comply with NFPA 70, "National Electrical Code."

I. NFPA Compliance: Provide fire alarm and detection systems conforming to the requirements of the following publications:

1. NFPA 72, "Installation, Maintenance, and Use of Protective Signaling Systems."
2. NFPA 72 Appendix B, "Automatic Fire Detectors."

J. NRTL Listing: Provide systems and equipment that are listed and labeled.

1. Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

K. UL Compliance: Provide fire alarm systems and components that are UL-listed.

L. Single-Source Responsibility: Obtain fire alarm components from a single source that assumes responsibility for compatibility for system components.

M. Certifications:

1. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

1.09 EXTRA MATERIALS

A. General: Furnish extra materials, matching products installed (as described below), and packaging with protective covering for storage, and identifying with labels clearly describing contents.

B. Glass Rods for Manual Stations: Furnish quantity equal to 15 percent of the number of manual stations installed: minimum of 6 rods.

C. Lamps for Strobe Units: Furnish quantity equal to 10 percent of the number of units installed, but not less than one.

D. Smoke Detectors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 10 percent of the number of units of each type installed but not less than one of each type.

E. Detector Bases: Furnish quantity equal to 2 percent of the number of units of each type installed but not less than one of each type.

1.10 GUARANTY

A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. All equipment in the system shall be the product of a single manufacturer and shall be marketed as a complete and functioning system. The addition of any components, systems and/or panels required, but not a product of the manufacturer, shall require certification of compatibility by the manufacturer.

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

1. See 1.01.C of this specification.

2. Acceptable manufacturer: The Fire alarm system that is depicted on the drawings and specifications is based on the system manufactured by Silent Knight. Any design or construction changes required to the layout, configuration, and/or installation including all wiring, devices, and other support appurtenances due to the furnishing of a system other than the Silent Knight system shall be the responsibility of and at the expense of the Contractor. Contractor shall also be responsible for submitting the layout plans and resolving any issues to satisfy the AHJ without any additional cost to the Owner. See section 1.01.C for more information relating to the AHJ.

2.02 EQUIPMENT

A. GENERAL

1. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.
2. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.
3. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.
4. Addressable devices shall use simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 001 to 127.
5. Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute.
6. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signaling Line Circuits. Detectors shall use Flash Scan technology.
7. Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.

B. FIRE ALARM CONTROL PANEL (FACP) OR FIRE ALARM SUB PANEL (FASP)

1. Main FACP shall be an intelligent analog/addressable fire control panel and shall contain a microprocessor based Central Processing Unit (CPU) and power supply in an economical space saving single board design. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules and other system controlled devices as shown on drawings.
2. Operator Control
    a. Acknowledge Switch:
        1) Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition.

2) Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

b. Alarm Silence Switch:

1) Activation of the alarm silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. The FACP software shall include silence inhibit and auto-silence timers.

c. Alarm Activate (Drill) Switch:

1) The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

d. System Reset Switch:

1) Activation of the System Reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.

e. Lamp Test:

1) The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

3. System Capacities and General Operation

a. The control panel shall provide, or be capable of a minimum of 127 SLC intelligent/addressable devices.

b. The control panel shall include Form-C alarm, trouble, supervisory, and security relays rated at a minimum of 2.5 amps @ 24 VDC. It shall also include four Class B (NFPA Style Y) or two Class A (NFPA Style Z) programmable Notification Appliance Circuits.

c. The system shall include a full featured operator interface control and annunciation panel that shall include a backlit 80 character Liquid Crystal Display (LCD), individual color coded system status LEDs, and an keypad with easy touch rubber keys for the field programming and control of the fire alarm system.

d. The system shall be programmable, configurable, and expandable in the field without the need for special tools, PROM programmers or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes.

e. The system shall allow the programming of any input to activate any output or group of outputs. Systems that have

limited programming (such as general alarm), have complicated programming (such as a diode matrix), or require a laptop personal computer are not considered suitable substitutes.

f. The FACP shall provide the following features:
   1) Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
   2) Detector sensitivity test, meeting requirements of NFPA 72, Chapter 7.
   3) Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
   4) The ability to display or print system reports.
   5) Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.
   6) PAS pre-signal, meeting NFPA 72 3-8.3 requirements.
   7) Rapid manual station reporting (under 3 seconds) and shall meet NFPA 72 Chapter 1 requirements for activation of notification circuits within 10 seconds of initiating device activation.
   8) Periodic detector test, conducted automatically by the software.
   9) Self-optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its pre-alarm level to just above normal peaks.
   10) Walk test, with a check for two detectors set to same address.

g. The FACP shall be capable of coding main panel node notification circuits in March Time (120 PPM), Temporal (NFPA 72 A-2-2.2.2), and California Code. Panel notification circuits (NAC 1,2,3 and 4) shall also support Two-Stage operation, Canadian Dual Stage (3 minutes) and Canadian Dual Stage (5 minutes). Two stage operation shall allow 20 Pulses Per Minute (PPM) on alarm and 120 PPM after 5 minutes or when a second device activates. Canadian Dual stage is the same as Two-Stage except will only switch to second stage by activation of Drill Switch 3 or 5 minute timer. The panel shall also provide a coding option that will synchronize specific strobe lights designed to accept a specific "sync pulse."

4. Central Microprocessor
    a. The microprocessor shall be a state-of-the-art, high speed, 16-bit RISC device and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, Flash memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.
    b. The microprocessor shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Control-by-event equations shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
    c. The microprocessor shall also provide a real-time clock for time annotation of system displays, printer, and history file. The time-of-day and date shall not be lost if system primary and secondary power supplies fail. The real time clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.
    d. A special program check function shall be provided to detect common operator errors.
    e. An auto-program (self-learn) function shall be provided to quickly install initial functions and make the system operational.
    f. For flexibility and to ensure program validity, an optional Windows(TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download, and have the ability to upgrade the manufacturers (FLASH) system code changes. This program shall also have a verification utility, which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in incompliance with the NFPA 72 requirements for testing after system modification.
5. System Display
    a. The system shall support the following display mode options:
        1) 80 character display option. The display shall include an 80-character backlit alphanumeric Liquid Crystal Display (LCD).
    b. The display shall provide all the controls and indicators used by the system operator:
        1) The 80-character display shall include the following operator control switches: ACKNOWLEDGE,

ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.

c. The display shall annunciate status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.
   1) The display shall also provide Light-Emitting Diodes.

d. The 80-character display shall provide 8 Light-Emitting-Diodes (LEDs), that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM WARNING, SECURITY ALARM, SUPERVISORY SIGNAL, SYSTEM TROUBLE, DISABLED POINTS, and ALARM SILENCED.

e. The LCD-80 display:
   1) This shall be part of the standard system and have the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.

f. The system shall support the display of battery charging current and voltage on the 80-character LCD display.

6. Signaling Line Circuits (SLC)
   a. Each FACP shall support one SLC interface and shall provide power to and communicate with intelligent detectors (ionization, photoelectric or thermal), intelligent modules (monitor or control) for a loop capacity of 127 devices. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
   b. CPU shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, pre-alarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

7. Notification Appliance Circuit (NAC) Module
   a. The Notification Appliance Circuit module shall provide four fully supervised Class A or B (NFPA Style Z or Y) notification circuits.
   b. The notification circuit capacity shall be 3.0 amperes maximum per circuit.
   c. The module shall not affect other module circuits in any way during a short circuit condition.

d. The module shall provide four green ON/OFF LEDs and four yellow trouble LEDs.
e. The module shall also provide a momentary switch per circuit that may be used to manually turn the particular circuit on or off or to disable the circuit.
f. Each notification circuit shall have a custom label to identify each circuit's location.
g. The notification circuit module shall have terminal strips UL listed for use with up to 12 AWG wire.
h. Each circuit shall be capable of, through system programming, deactivating upon depression of the signal silence switch.

8. Control Relay Module
   a. The control relay module assembly shall provide two Form-C auxiliary relay circuits rated at 2.5 amperes, 24 VDC.
   b. Each relay circuit shall be capable of being activated (change in state) by any initiating device or from any combination of initiating devices.
   c. The module shall provide a momentary switch per relay circuit that may be used to manually turn the relay ON/OFF or to disable the relay.
   d. Each relay circuit shall include a custom label to identify its location.
   e. The control relay module shall have terminal blocks UL listed for use with up to 12 AWG wire.
9. Enclosures:
   a. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
   b. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.
   c. The door shall provide a key lock and shall include a glass or other transparent opening, as applicable, for viewing of all indicators. For convenience, the door may be site configured for either right or left hand hinging.
10. Power Supply:
    a. A high tech off-line switching power supply shall be available for the fire alarm control panel or network node and provide 6.0 amps of available power for the control panel and peripheral devices.
    b. Provisions will be made to allow the audio-visual power to be increased as required by adding modular expansion audio-visual power supplies.

c. Positive-Temperature-Coefficient (PTC) thermistors, circuit breakers, or other over-current protection shall be provided on all power outputs. The power supply shall provide an integral battery charger for use with batteries up to 33 AH or may be used with an external battery and charger system. Battery arrangement may be configured in the field.

d. The power supply shall continuously monitor all field wires for earth ground conditions, and shall have the following LED indicators:
   1) Ground Fault LED
   2) AC Power Fail LED
   3) NAC on indication

e. The main power supply shall operate on 120 VAC, 60 Hz, and shall provide all necessary power for the FACP.

f. The main power supply shall provide a battery charger using dual-rate charging techniques for fast battery recharge and be capable of charging batteries up to 33 AH.

g. All circuits shall be power-limited, per UL864 requirements.

11. Specific System Operations

a. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any, or all, addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window.

b. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 5 to 30 seconds and each detector shall be able to be selected for verification.

c. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

d. Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.

e. Point Read: The system shall be able to display or print the following point status diagnostic functions:
   1) Device status
   2) Device type
   3) Custom device label
   4) View analog detector values
   5) Device zone assignments

6) All program parameters

f. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system status.

g. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 200 events minimum. Up to 50 events shall be dedicated to alarm and the remaining events are general purpose. Systems that do not have dedicated alarm storage, where events are overridden by non-alarm type events, are not suitable substitutes. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.

h. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display, and printed on the optional printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

i. Pre-Alarm Function: The system shall provide two levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.

j. Software Zones: The FACP shall provide 100 software zones, 10 additional special function zones, 10 releasing zones, and 20 logic zones.

k. The fire alarm control panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:

1) Alarming an initiating device shall activate programmed outputs, which are selected to participate in walk test, for 3 seconds.
2) Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.
3) All devices tested in walk test shall be recorded in the history buffer.

12. Supervisory Operation
    a. An alarm from a supervisory device shall cause the appropriate indication on the system display, light a common supervisory LED, but will not cause the system to enter the trouble mode.
13. Signal Silence Operation
    a. The FACP shall have the ability to program each output circuit (notification, relay, speaker etc) to deactivate upon depression of the signal silence switch.

C. INITIATING DEVICES

1. General: Comply with UL 268. Include the following features:
    a. Factory Nameplate: Serial number and type identification.
    b. Operating Voltage: 24-V DC, nominal.
    c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
    d. Plug-In Arrangement: Detector and associated encapsulated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. The plug connection requires no springs for secure mounting and contact maintenance. Terminals in the fixed base accept building wiring. Design detector for mounting on interchangeable type base, capable of operating on either 2-wire or 4-wire loop. For Class A Style 7 systems, base shall contain internal isolation so that no external isolation device is necessary.
    e. Visual Indicator: Connected to indicate detector has operated. Provide flashing LED indicator for normal operation, which changes to steady on alarm condition.
    f. Addressability: Detectors include a communication transmitter and receiver having a unique identification and capability for status reporting to the FACP.
    g. Remote Controllability: Individually monitor detectors at the FACP for calibration, sensitivity, and alarm condition, and individually adjust for sensitivity from the FACP.

i. Each of the intelligent addressable detector in the system may be independently selected and enabled to be an alarm verified detector The FACP shall keep count of the number of times each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

j. Detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

k. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

l) Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values.

2. Addressable Photoelectric Smoke Detectors:
   a. Detector Sensitivity: Between 2.5- and 3.5-percent-per-foot smoke obscuration when tested according to UL 268.
   b. Sensor: An infrared or LED light source with matching photo diode receiver.
   c. Furnish with isolator integral to base for Class A Style 7.
3. Addressable Photoelectric Duct Smoke Detector:
   a. Photoelectric-type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied shall be used within the duct housing mounted in the proper location as per NFPA 72 and 90A. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to take over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system. Fan shutdown shall occur throughout the entire building on a general basis. Duct sampling tubes shall extend the entire width of the A/C ductwork. Remote test stations shall be provided for each duct mounted smoke detector.
   b. Furnish housing with detector, sampling tube and remote test switch. Coordinate exact sampling tube size with HVAC.
4. Addressable Thermal (Heat) Detector:
   a. Fixed-temperature type using externally mounted thermistor with plug-in base and alarm indication lamp. Detectors have

a communication transmitter and receiver with unique identification and capability for status reporting to the FACP. Device shall be rated 150°F (65 °C).

b. Furnish with isolator integral to base for Class A Style 7.

5. Beam Detector:

a. U.L. 268 listed, two-component infrared detector consisting of a separate transmitter and receiver. Operation based upon the absorption or scattering of the infrared beam by smoke creates a reduction in signal and alarm condition. If 95% or more of the beam is blocked the unit shall transmit a trouble signal. The unit shall be self-resetting and shall feature automatic gain control to compensate for dirt depreciation. The beam detector shall be designed to operate on 24VDC 4 wire applications. Detector sensitivity shall be selectable at 30% or 55% Total Obscuration. Detector range shall be from 30 to 300 ft in an ambient temperature of -22°F to 131°F. Unit shall be easily aligned without special tools. Provide a remote test station to remotely test each set of beam detectors. Unit shall be capable of either wall or ceiling mount.

b. Provide separate addressable monitor module for connection to addressable system.

6. Addressable Manual Pull Stations

a. Description: U.L. Listed, double-action or single action type, fabricated of metal or plastic, and finished in red with molded, raised-letter operating instructions of contrasting color. Stations requiring the breaking of a glass panel are not acceptable. Stations requiring the breaking of a concealed glass rod may be provided.

b. Station Reset: Key-operated, double-pole, double-throw, switch-rated for the voltage and current at which it operates. The key shall operate a test-reset lock, and shall be designed so after actual emergency operation, they cannot be restored to normal use except by the use of a key.

c. Addressable pull stations 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.

d. Indoor general use: provide manufacturer's standard unit. Outdoor, weather resistant and corrosion resistant use: furnish a die cast metal manual pull station with addressable monitor module.

D. NOTIFICATION APPLIANCES

1. Horn/Strobe
    a. Horn/strobe shall be UL 1971 and UL 464 listed, operates on 24VDC, and shall be approved for fire protective service. Unit shall be wired as a primary signaling notification appliance and shall comply with ADA requirements for visible signaling appliances, flashing at 1 Hz over the strobes entire operating voltage range. Operating voltage range shall be 17-33VDC.
    b. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. The horn shall be temporal 3 pattern at 24 VDC. Strobes shall be powered independently of the sounder with the removal of factory installed jumper wires. The horn shall operate on a coded or non-coded power supply.
    c. Supply appliances rated for the conditions in which installation will take place. Appliances to be used in outdoor, wet or corrosive locations shall have appropriate materials of construction and degradation resistance.
2. Strobe
    a. Unit shall be UL 1971 listed, operates on 24VDC, and shall be approved for fire protective service. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Unit shall be wired as a primary signaling notification appliance and shall comply with ADA requirements for visible signaling appliances, flashing at 1 Hz over the strobes entire operating voltage range. Operating voltage range shall be 17-33VDC.
    b. Supply appliances rated for the conditions in which installation will take place. Appliances to be used in outdoor, wet or corrosive locations shall have appropriate materials of construction and degradation resistance.
3. Synchronization Module
    a. Synchronization Module shall be UL 464 listed and shall be approved for fire protective service. The unit shall synchronize strobes at 1 Hz and horns at temporal 3. Also, the module shall silence the horns on horn/strobe units, while operating the strobes, over a single pair of wires. The module shall control two Class B (Style Y) or one Class A (Style Z) circuit. Module shall be capable of multiple-zone synchronizing by daisy chaining multiple modules together and re-synchronizing each other along the chain.

E. ACCESSORIES

1. Addressable Input Module
    a. Addressable input modules shall be provided to connect one supervised alarm initiating device circuit zone of conventional, dry contact, alarm initiating devices (or single non-addressable conventional alarm initiating device) to one of the fire alarm control panel SLC'S. Unit shall operate on Class A, Style 7. Unit shall fit in a standard 4" square box.
    b. The alarm-initiating device 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.
    c. For difficult to reach areas, the input module shall be available in a miniature package that shall fit in a single gang box.
2. Addressable Relay Module
    a. Addressable Relay Module assemblies shall be used for HVAC control, elevator recall, exhaust fan operation and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps @ 30V DC or 0.6A @120VAC. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NAC'S may be energized at the same time on the same pair of wires. Unit shall mount in a 4" square box.
3. Line Isolator Module
    a. Line isolator modules shall isolate a short circuit fault on a Class A Style 7 SLC without disrupting the communication on the remainder of the circuit. Unit shall operate on mount in a standard 4" box.
4. Batteries
    a. The battery shall be rechargeable sealed lead-acid type with sufficient capacity to power the fire alarm system for not less than twenty-four hours plus five minutes of alarm upon a normal AC power failure.
    b. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.
    c. If necessary to meet standby requirements, external battery and charger systems may be used.
    d. Battery enclosures shall be ventilated if necessary to meet standby requirements.
    e. Provide material safety data sheets for all batteries supplied.
5. Surge Suppression

a. TVSS protection shall be provided to protect the electronic components from induced surges propagating along the signal and power supply lines. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the device surge withstand level, and be maintenance free and self-restoring.

b. Devices shall be housed in a suitable case, properly grounded. Ground wires for all TVSS shall be connected to the building grounding counterpoise and where practical, each ground wire run individually and insulated from each other. These protectors shall be mounted within the device enclosure or a separate junction box next to the enclosure.

c. Power Supply:
   1) Protection of all 120 VAC FACP power supply lines shall be provided.

d. Signal Line and Notification Appliance Circuits
   1) Protection of SLCs and NACs originating and terminating not in the same building shall be provided by TVSS.

2.03 CONDUIT AND WIRE:

A. Conduit:

1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
2. All conductors shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
3. Fire alarm conductors shall be separate from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these types of conductors, per NEC Article 760-29.
4. Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
6. Conduit shall be 3/4-inch (19.1 mm) minimum painted red.
7. Exposed conduits installed indoors shall be manufactured by Allied Tube and Conduit, type Fire Alarm EMT with E-Z Pull Coating or approved equal.

B. Wire:

1. All fire alarm system wiring shall be new.
2. Wiring shall be in accordance with state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 16 AWG (1.29 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wiring used for the multiplex communication circuit (SLC) shall be twisted and unshielded and support a minimum wiring distance of 6,000 feet. The design of the system shall permit use of NAC wiring in the same conduit with the SLC communication circuit.
5. All field wiring shall be electrically supervised for open circuit and ground fault.
6. Class A: 4-wire initiating and 2-wire alarm indicating circuits with electrical supervision for shorts and open conditions.

C. Terminal Boxes, Junction Boxes and Cabinets:

1. All boxes and cabinets shall be UL listed for their use and purpose. All junction boxes must be painted red and identified as fire alarm.
2. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.
3. The fire alarm control panel shall be connected to a separate dedicated branch circuit, minimum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold water pipe or grounding rod.
4. Provide basic wiring materials that comply with Division 16.

2.04. TAGS

A. Tags For Identifying Tested Components: Comply with NFPA 72.

B. Test Chart Instructions: Provide fire alarm system test instructions chart mounted in lexan enclosed frame assembly on control cabinet hinged door or adjacent to control panel.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Installation shall be in accordance with the NEC, NFPA 72, Local County and state codes, as shown on the drawings, and per the major equipment manufacturer specifications.

B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

D. Manual pull stations shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

E. Install in accordance with plans and supplier's data sheets. Provide "as-built" data to Engineer upon completion.

F. After installation, the fire alarm system shall be balanced, checked, operated and certified in writing as operational by factory representative or agency. Certify by letter that system is installed in accordance with data sheets and conforms to plans and specifications. CONTRACTOR shall obtain a written approval of the installed fire alarm system from the Fire Chief and send one (1) copy to the Owner and one (1) copy to the Engineer.

G. Installation and maintenance manuals shall be provided on all components and the system.

H. Number, size and type of wires shall be as specified by Equipment Manufacturer. Conduit type and size shall be as per NEC.

G. Submit as-built drawings including, but not limited to, dimensional drawings, installation instructions, operation instructions, and wiring diagram for all fire alarm equipment and wiring diagrams for all fire alarm equipment and wiring.

I. Fire Alarm Power Supply Disconnect: Paint red and label "FIRE ALARM." Provide with lockable handle or cover.

3.02 EQUIPMENT INSTALLATION

A. Manual Pull Stations: Mount semi-flush in recessed back boxes with operating handles in accordance with ADA requirements.

B. Smoke Detectors: Install ceiling-mounted detectors not less than 4 inches from a sidewall to the near edge. Install detectors located on the wall at least 4 inches but not more than 12 inches below the ceiling. For exposed solid joist construction, mount detectors on the bottoms of the joists. On smooth ceilings, install detectors not over 30 feet apart in any direction. Install detectors no closer than 5 feet from air registers. Detectors installed in suspended ceiling tiles shall be supported from structure above using T-bar hangers per NEC article 300.

C. Audible Alarm-Indicating Devices: Install not less than 80 inches above the finished floor nor less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille or as indicated. Combine audible and visual alarms at the same location into a single unit. In process areas, mounting height shall be between 80 inches and 96 inches as necessary depending upon process equipment layout.

D. Visual Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and not less than 80 inches above the finished floor and at least 6 inches below the ceiling. In process areas, mounting height shall be between 80 inches and 96 inches as necessary depending upon process equipment layout.

E. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.

F. Fire Alarm Control Panel (FACP) and/or Remote Annunciator Panel: Surface mount with tops of cabinets not more than 6 feet above the finished floor.

3.03 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceway according to Division 16 Section "Raceways." Conceal raceway except in unfinished spaces and as indicated.

B. Wiring Within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the wiring diagrams of

the system. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where any circuit tap is made.

D. System Wiring: For the low-voltage portion of the fire alarm system, install No. 18 VNTC conductors for SLC and 75-deg C THWN insulation in wet or damp locations. For NAC wiring, install No. 12 AWG THWN with insulation rated 75 deg C minimum in wet or damp locations.

E. Risers: Install at least 2 vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum two-hour-rated wall or a minimum of 10 feet of separation, so the loss of one riser does not prevent the receipt or transmission of signal from other floors or zones.

3.04 GROUNDING

A. Ground equipment and conductor and cable shields. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.05 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B. Pre-testing: Upon completing installation of the system, align, adjust, and balance the system and perform complete pre-testing. Determine, through pre-testing, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

C. Report of Pre-testing: After pre-testing is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.

D. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

E. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72 Chapter 7. All testing shall be completed by a factory-trained/certified technician authorized by the manufacturer of the fire alarm equipment. The CONTRACTOR shall technically supervise and participate

during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7 and shall meet all city requirements to the satisfaction of the Fire Marshall. Minimum required tests are as follows:

1. Verify the absence of unwanted voltages between circuit conductors and ground.
2. Megger test all conductors other than those intentionally and permanently grounded with electronic components disconnected. Test for resistance to ground and conductor to conductor. Report readings less than 100-megohm for evaluation.
3. Test all conductors for short circuits utilizing an insulation-testing device.
4. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.
5. Verify the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
6. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
7. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
8. Test the system for all specified functions according to the manufacturer's operating and maintenance manual. Systematically initiate specified functional performance items at each station including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all system devices, affected by the item, under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, and quality, freedom from noise and distortion, and proper volume level.
9. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the period and in the manner specified.
10. Open initiating device circuits and verify that the trouble signal actuates.
11. Open and short signaling line circuits and verify that the trouble signal actuates.
12. Open and short notification appliance circuits and verify that trouble signal actuates.
13. Ground all circuits and verify response of trouble signals.

14. Check presence and audibility of tone at all alarm notification devices.
15. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.

F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests.

H. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

3.06 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean unit internally using methods and materials recommended by the manufacturer.

B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.07 DEMONSTRATION

A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours' training.
2. Schedule training with the Owner at least seven days in advance.

END OF SECTION

SECTION 16740

ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, coordinate installation by the electrical contractor, and test all Access Control System (Card Reader System) components, UPS and accessories required for a complete and operable system, in accordance with the requirements of the Contract Documents. The design drawings only show major devices for access control system and Contractor shall provide all necessary card reader, magnetic door lock, request to exit, magnetic door contact, exit motion sensors, cables, special connector, devices, etc. not specified but obviously necessary for a complete and working access control system in place. All the access control devices are only required for the doors identified in the Contract drawings to be equipped with access control system. See electrical drawings for additional information.

B. The Contractor shall furnish, install, and terminate all cables to all Access Control System equipment and devices, and to other vendor-furnished equipment, as required to integrate the system. Coordinate with electrical contractor for conduit requirements and locations to stub-up conduits.

C. New Access Control System shall communicate with Main access control panel at Operations Building. Furnish all necessary communication module at both existing access control panel at Operation Building and new panel at Maintenance Building for a complete access control system in place. Program main access control panel so that existing cards can be used for new Maintenance Building Access Control system.

F. All equipment furnished by the Contractor shall be listed by and shall bear the label of Underwriters' Laboratories, Incorporated (UL), as applicable.

G. Prior to submission of design, the access control system supplier shall meet with Owner and Engineer to verify all access control device placement and adjust as needed.

H. All necessary raceway/conduits and junction boxes shall be supplied by the Electrical Contractor. Access Control System shall be installed under the supervision of the Electrical Contractor so that no additional low voltage permit is needed. Coordinate with Electrical Contractor to meet all requirements to fall under the Electrical Contractor's low voltage permit

before bidding. If Access Control System Supplier does not meet the requirements to fall under the Electrical Contractor's low voltage permit, he/she shall supply additional permit as needed with no additional cost to the Owner.

1.02 VENDOR QUALIFICATIONS

A. It shall be the intent of this specification to obtain the system vendor who shall provide Access Control System as shown on the Contract Drawings and as specified herein. This Contractor, herein referred as Security System Integrator shall be located within 30 miles of the project site and shall be available to service the equipment as may be required within 24 hours of notice.

B. The Security Systems Integrator shall integrate the Access Control systems into one security system.

C. The System Provider shall have pervious experience on projects of similar scope for Orange County Utilities. Manufacturer of the Access Control System shall be Lenel and Security System Integrator shall be Ingersoll Rand Security Technologies.

1.03 CONTRACTOR SUBMITTALS

A. Shop drawings and catalog data submittals shall be made in accordance with Section 01300 - Submittals. The Contractor shall submit sufficient information to indicate the scope and quality of the plant Access Control System installation.
   1. Block diagram showing system relationships of major components and quantities and interconnecting cable requirements.
   2. Plans showing equipment location, raceway, and conductor requirements.
   3. Control console and panel arrangements, equipment outlet devices, and special mounting details.
   4. Wiring diagrams showing terminal identification for field-installed wiring and overwall networking wiring diagram.
   5. Overall system description including the integration of the Access Control systems
   6. Catalog literature for Access Control equipment and devices.

B. The Contractor shall furnish the operating service manual for each system as per Section 01300. The manuals shall be bound in flexible binders and all data contained therein shall be typewritten. Each manual shall include all instructions necessary for proper operation and receiving of each system, and a complete block diagram of each system, a complete circuit

diagnosis of each system, and a wiring designation schedule for the control panels, as well as other major components, and a replacement parts list.

1.04 QUALITY ASSURANCE

A. The Access Control System components shall be manufactured by firms that are regularly engaged in the production of equipment similar to that required for this project and that have been in satisfactory service for at least 10 years.

B. The Contractor installing the Access Control System shall have had prior successful installation experience with these systems in similar scope to the system of this project.

C. The Contractor shall post a typewritten notice, at the main control panel, to indicate the name, address, and telephone number of the firm to call when service is necessary. Notice shall be mounted in a metal frame attached to the panel case.

D. Operation of the systems shall be demonstrated to the Engineer to prove, under normal conditions, that coverage complies with these Specifications.

1.05 MANUFACTURERS' SERVICES

A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment and accessories furnished under this Section of the Specifications, and provide training to the Owner's personnel in the operation and maintenance of the unit(s).

B. Provide two hours of one-site training with staff for this project.

1.06 WARRANTY

A. Warranty: Equipment furnished under this section shall be guaranteed against defective parts and workmanship under the terms of the manufacturer's and supplier's standard warranty. In no event shall it be for a period of less than one (1) year from date of final acceptance of the systems and shall include labor, materials and travel costs for necessary repairs at the job site.

PART 2 - PRODUCTS

2.01 SYSTEM COMPONENTS FOR FACILITY ACCESS CONTROL

A. Control Panels: NEMA 1 enclosure surface/wall mount. Each panel shall support four card readers, 16 alarm inputs and relay outputs – four and eight expandable to twenty four and shall have networking capability to interconnect to the existing main security access control system.

B. Proximity Card Readers (both interior and weatherproof exterior models capable interface with Wiegand style cards) shall be surface mount and have red and green LED indicators and audio sounder as per ADA requirements.

C. Electro-Magnetic Door Locks, Power Supplies, Battery-Back-up, provided and installed by the Access Control System Supplier. Coordinate with Architectural drawings for door type.

D. Request to Exit Devices: Motion sensors designed and manufactured for this application only (there will be no exceptions). New doors shall be crash bar with auxiliary contacts and motion sensors. See door hard ware specification for crash bar. Coordinate with crash bar supplier for termination requirements.

E. Magnetic Door Contacts (access hatch, pedestrian and overhead door styles) shall contain a contact and activating block. The contact block shall contain transfer type SPDT set of contacts and be mounted on the door frame. The activating block shall contain a permanent magnet and be mounted to the door. Overhead door and access hatch contacts shall be floor or wall mounted model, extra heavy duty comprised of aluminum bar stock with 3" gap contacts and 3' stainless steel armored cable lead.

F. Exit Motion Sensor: Exit motion sensor shall be Detection Systems Model: DS-9360 or DS-860 or approved equal.

G. Access Control cables and other miscellaneous access control device needed for a complete and working system shall be provided by this specification.

2.02 MANUFACTURER.

A. Lenel Systems International, Inc. In order to be compatible with the existing Orange County Utilities Access Control System, no equal

manufacturer will be considered. Contractor may use a different device model from the Ingersoll Rand Security Technologies at the time of construction if the listed model is obsolete or County's standard is replaced with a newer model

2.03 SYSTEM FEATURES

A. Access Control System shall have the following features:

1. Reader compatibility: Proximity type with dual encoding for time and attendance systems.

2. Panel primary power: 100 to 127 volts AC, 50 - 60 Hz, 16.5 VAC, 50 VA, Class 2 plug-in transformer.

3. Panel secondary power: 12 VDC, 7 AH rechargeable battery, interior battery charger and monitor, back-up capabilities for 4-hour.

4. Auxiliary power: 1.6A, total continuous.

5. Panel enclosure: 14"H x 16"W x 4"D with lock and tamper switches.

6. Surge Suppression for all components of the system.

7. Provide and install a 550VA UPS system for each access control panel. See specification 13300 for UPS requirements and provide accordingly.

2.02 CURRENT ORANGE COUNTY UTILITIES ACCESS CONTROL DEVICE MODEL

A. Lenel intelligent control panel: Model: LNL-2220

B. Lenel reader board: Model: LNL-1320.

C. Lenel power supply enclosure: Model: LNL-AL600ULX-4CB6.

D. Altronix power supply with batteries for Locks: Model: AL600ULACM.

E. 18/6 stranded plenum cables for each door.

F. 18/6 stranded shielded plenum cables for each door.

G. 18/4 stranded plenum cables for each door.

H. Contractor may use a different model from the manufacturer listed above at the time of construction if the listed model is obsolete or County's standard is replaced with a newer model with no additional cost to the Owner.

2.02 MANUFACTURER

A. Extent of Access Control System shall be as indicated by drawings, schedules, riser diagrams, and as required for a complete system. System shall be manufactured by "Lenel (Ingersoll Rand Security Technologies)" to match and be compatible with existing Orange County Utilities Access Control system. The Access Control System shall match the existing system. Employees shall have the ability to utilize the same user Prox card at both new and existing locations.

PART 3 - EXECUTION

3.01 GENERAL

A. All materials and equipment shall be installed in accordance with the manufacturers printed recommendations and the requirements of the Contract Documents. All cables shall be pulled and terminated per manufacturer's recommendation. Equipment shall be installed, adequately ventilated, and securely anchored.

B. If the raceway shown does not conform to the requirements of the Access Control systems to be installed, it is incumbent upon the Contractor to provide the raceway system required at no additional cost to the Owner.

C. Security System Integrator shall be coordinate with Electrical Contractor for the conduits and cables installation. The security system integrator shall be under the scope of electrical contractor (division 16) so that no additional low voltage permit shall be required. Otherwise, security system integrator shall be responsible for applying and paying related feeds to obtain the low voltage permit.

3.02 WORKMANSHIP

A. Conductor terminations at screw terminals shall be accomplished with hooked, spade, lugs. Shielding shall be continuous and shall be grounded as per manufacturers instructions. Wiring shall be cabled within enclosures and banded neatly to terminals. Conductors and cables shall be rated for installation in wet locations.

3.03 INSTALLATION

A. Units shall be installed as per manufacturers written instructions. Wiring throughout the system shall be identified in accordance with approved shop drawings; identification shall be applied at all terminations and junction boxes.

B. Contractor shall provide the services of a programmer experienced with existing access/security control system Computers to program Access Control System.

   a. Program the new Access Control systems at proposed Operations building Access Control System.

   b. Program the system to receive an alarm input from fire alarm system and unlock the doors associated with security access control system.

C. It is the Contractor's responsibility to provide all necessary hardware, software, devices, programming, etc. for a complete working access control system in place.

3.04 EXECUTION OF TEST PROCEDURES

A. The Contractor shall operate all equipment in the presence of the Engineer and Owner. Operation shall demonstrate the Access Control System performance is satisfactory and is integrated into the Owner's system. At completion of test, all adjustments shall be locked or sealed.

END OF SECTION

SECTION 16950

ELECTRICAL TESTING

PART1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):
   a. 450, Recommended Practice for Maintenance, Testing, and Replacement of Large lead Storage Batteries for Generator Stations and Substations.
   b. C2, National Electrical Safety Code.
   c. C37.20.1, Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
   d. C37.20.2, Metal-Clad and Station-Type Cubicle Switchgear.
   e. C37.20.3, Metal-Enclosed Interrupter Switchgear.
   f. C62.33, Standard Test Specifications for Varistor Surge- Protective Devices.
2. American Society for Testing and Materials (ASTM):
   a. D665, Standard Test Method for Rust Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water.
   b. DS77, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   c. D923, Standard Test Method for Sampling Electrical Insulating Liquids.
   d. D924, Standard Test Methods for A-Class Characteristics and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
   e. D971, Standard Test Method for Interfacial Tension of 0.1 Against Water by the Ring Method.
   f. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   g. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   h. D1500, Standard Test Method for ASTM Color of Petroleum Products.
   i. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
   j. D1533, Standard Test Methods for Water in Insulating Liquids.

k. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.
l. D2285, Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin Against Water by the Drop-Weight Method.

3. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.
   b. 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminators.
   c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   d. 95, Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.
   e. 118, Standard Test Code for Resistance Measurement.
   f. 400, Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.
4. National Electrical Manufacturers Association (NEMA):
   a. AB 4, Guideline for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
   b. PB 2, Deadfront Distribution Switchboards.
   c. WC 7, Cross-Linked-Thermosetting-Polyethylene- Wire and Cable for the Transmission and Distribution of Electrical Energy.
   d. WC 8, Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
5. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70E, Standard for Electrical Safety Requirements for Employee Workplaces.

1.02 SUBMITTALS

A. Administrative Submittals: Submit 30 days prior to performing inspections or tests:

1. Schedule for performing inspection and tests.
2. List of references to be used for each test.
3. Sample copy of equipment and materials inspection form(s).
4. Sample copy of individual device test form.
5. Sample copy of individual system test form.

B. Quality Control Submittals: Submit within 30 days after completion of test:

1. Test or inspection reports and certificates for each electrical item tested.

C. Contract Closeout Submittals:

1. Operation and Maintenance Data:
   a. In accordance with Section 01430, OPERATION AND MAINTENANCE DATA.
   b. After test or inspection reports and certificates have been reviewed by ENGINEER and returned, insert a copy of each in operation and maintenance manual.

1.03 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers, of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologists (NICET), or International Electrical Testing Association and having a minimum of 5 years testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to project at ratio not to exceed two certified to one noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA Title 29, Part 1907 criteria for accreditation of testing laboratories or a full Member Company of International Electrical Testing Association.

B. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

C. Test instrument calibration shall be in accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment are to be:

1. Scheduled with ENGINEER prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify ENGINEER at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. Tests specified in this section are to be performed in accordance with the requirements of Section 01650, START-UP and DEMONSTRATION.

B. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer's tolerances.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Set, test, and calibrate protective relays, circuit breakers, fuses, and other applicable devices in accordance with values established by the short circuit and coordination study as specified in Section 16015, ELECTRICAL SYSTEMS ANALYSIS.

E. Adjust mechanisms and moving parts for free mechanical movement.

F. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance to Contract Documents.

H. Realign equipment not properly aligned and correct un-levelness.

I. Properly anchor electrical equipment found to be inadequately anchored.

J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of applicable moving parts.

M. Inform ENGINEER of working clearances not in accordance with NFPA 70.

N. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

O. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by ENGINEER, door and panel sections having dented surfaces.
5. Repair or replace, as determined by ENGINEER, poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
    a. Provide matching paint and touch up scratches and mars.
    b. If required due to extensive damage, as determined by ENGINEER, refinish the entire assembly.

P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

Q. Replace transformer insulating oil not in compliance with ASTM D923.

3.02 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Power Cable No. 6 and Larger For:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.
   c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
   d. Color coding conformance with specifications.
   e. Proper circuit identification.
2. Mechanical Connections For:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 10. 1, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.
4. Control Cables For:
   a. Proper termination.
   b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:

1. Insulation Resistance Tests:
   a. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.
   b. Evaluate ohmic values by comparison with conductors of same length and type.
   c. Investigate values less than 50 megohms.
   d. Utilize 1,000V dc megohmmeter for 600V insulated conductors.
2. Continuity test by ohmmeter method to ensure proper cable connections.

3.03 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.

4. Proper contact-to-contact tightness between fuse clip and fuse.
5. Cable connection bolt torque level in accordance with NETA ATS, Table 10.1.
6. Proper phase barrier material and installation.
7. Verify that fuse sizes and types correspond to one-line diagram.
8. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.
   b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
   c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each switch blade and fuse holder.
   b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.04 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 70 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 10.1.
6. Operate breaker to verify smooth operation.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480- and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.

b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
d. Test values to comply with NETA ATS, Table 10.2.

2. Contact Resistance Tests:
a. Contact resistance in microhms across each pole.
b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.

3. Primary Current Injection Test to Verify:
a. Long-time minimum pickup and delay.
b. Short-time pickup and delay.
c. Ground fault pickup and delay.
d. Instantaneous pickup by run-up or pulse method.
e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
f. Trip times shall be within limits established by NEMA AB 4, Table 5-3.
g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4.

3.05 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually Check Current, Potential, and Control Transformers For:
a. Cracked insulation.
b. Broken leads or defective wiring.
c. Proper connections.
d. Adequate clearances between primary and secondary circuit wiring.

2. Verify Mechanically That:
a. Grounding and shorting connections have good contact.
b. Withdrawal mechanism and grounding operation, when applicable, operate properly.

3. Verify proper primary and secondary fuse sizes for potential transformers.

B. Electrical Tests:

1. Current Transformer Tests:
a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.
b. Polarity test.

2. Potential Transformer Tests:

a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 7.1.1 for 1 minute on:
   1) Winding-to-winding.
   2) Winding-to-ground.
b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.

3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

3.06 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control centers, panelboards, switchboards, and switchgear assemblies for proper connection and tightness.
2. Ground bus connections in motor control centers, panelboards, switchboards, and switchgear assemblies for proper termination and tightness,
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

1. Fall-Of-Potential Test:
   a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
   b, Main ground electrode system resistance to ground to be no greater than 5 ohms.
2. Two-Point Direct Method Test:
   a. In accordance with IEEE 81, Section 8.2. 1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
   b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

3.07 THERMOGRAPHIC SURVEY

A. Provide a thermographic survey of connections associated with incoming service conductors, bus work, and branch feeder conductors No. 2 and larger at each:

1. Medium voltage switchgear and transformer.
2. Switchboard.
3. Low voltage motor control center.
4. Panelboard.

B. Provide a thermographic survey of feeder conductors No. 2 and larger terminating at:

1. Motors rated 30 horsepower and larger.
2. Medium and low voltage disconnect switches.
3. Transfer switches.
4. Engine-generators.

C. Remove necessary enclosure metal panels and covers prior to performing survey.

D. Perform with equipment energized during periods of maximum possible loading.

E. Do not perform survey on equipment operating at less than 20 percent of rated connected operating load.

F. Utilize Thermographic Equipment Capable Of:

1. Detecting emitted radiation.
2. Converting detected radiation to visual signal.
3. Detecting 1 degree C temperature difference between subject area and reference point of 30 degrees C.

G. Temperature Gradients Of:

1. 3 degrees C to 7 degrees C indicates possible deficiency that warrants investigation.
2. 7 degrees C to 15 degrees C indicates deficiency that is to be corrected as time permits.
3. 16 degrees C and above indicates deficiency that is to be corrected immediately.

H. Provide Written Report Of:

1. Areas surveyed and the resultant temperature gradients.

2. Locations of areas having temperature gradients of 3 degrees C or greater.
3. Cause of heat rise and actions taken to correct the cause of heat rise.
4. Detected phase unbalance.

END OF SECTION

APPENDIX A

APPENDIX A

LIST OF APPROVED PRODUCTS

ORANGE COUNTY UTILITIES
LIST OF APPROVED PRODUCTS
(February 11, 2011)

APPENDIX D **LIST OF APPROVED PRODUCTS - TRANSMISSION SYSTEMS** **FEBRUARY 11, 2011**

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater	
			Model #	Comments	Model #	Comments	Model #	Comments
Air Release	ARV Enclosure	**All ARV above ground enclosures shall be vented with tamper proof locking device**						
		Water Plus Polyethylene Enclosure	131632 H30-B	Blue 44" Tall	131632 H30-P	Pantone 44"	131632 H30-G	Green 44" Tall
			171730 H40-B	Blue 30" Tall	171730 H40-P	Pantone 30"	171730 H40-G	Green 30" Tall
		Hot Box Vent Guard Fiberglass Enclosure	AVG2036 Encl GP3232 Base	Blue 36" Tall	AVG2036 Encl GP3232 Base	Pantone 36" Tall	AVG2036 Encl GP3232 Base	Green 36" Tall
			AVG2041 Encl GP3232 Base	Blue 41" Tall	AVG2041 Encl GP3232 Base	Pantone 41" Tall	AVG2041 Encl GP3232 Base	Green 41" Tall
		Safety-Guard/Hydro Guard	15100 Encl	Blue 34" Tall	15100 Encl	Pantone 34" Tall	15100 Encl	Green 34" Tall
	Air Release Valves	**Air Release Valves shall be Combination Type, 316 SS**						
		ARI	D-040SS	Combination	D-040SS	Combination	D-020 (SS)	Combination
		H-TEC	NA	NA	NA	NA	986 (316SS)	Combination
		Vent-O-Mat	Series RBX DN50	2"	Series RBX DN50	2"	RGX series	
	ARV Vault	**Air Release Valve Frame and Cover**						
		US Foundry	NA	NA	NA	NA	USF 7665-HH-HJ	
Blow Off	Auto Blow Off	**Automatic Blow Off Valve**						
		Hydro Guard	HG-1 Standard Unit	Automatic	NA	NA	NA	NA
	Blow Off Valve	**Blow Off Valve - Fits standard 5-1/4 inch Valve Box**						
		Kupferle Foundry Co	Truflo Series TF #550		Truflo Series TF #550		NA	NA
		Water Plus Corp	The Hydrant Plus Series VB 2000B		The Hydrant Plus Series VB 2000B		NA	NA
Casing Seals / Spacers	Casing End Seals	**Casing End Seals. Annular space between pipe and steel casing shall be brick and mortar with end seals to secure ends.**						
		Advance Products	Model AC and AW		Model AC and AW		Model AC and AW	
		BWM Company	Model WR and PO		Model WR and PO		Model WR and PO	
		Cascade Water Works	Model CCES		Model CCES		Model CCES	
		CCI Pipeline	Model ESW and ESC		Model ESW and ESC		Model ESW and ESC	
		Pipeline Seal & Insulator, Inc (PSI)	Model C and W		Model C and W		Model C and W	
		Power Seal	Model 4810ES		Model 4810ES		Model 4810ES	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Casing Seals / Spacers	Casing spacer	**Casing spacers shall be a min. 8-inches wide for pipe 12" Dia or less or min. 12-inches wide for pipe 16 or greater , shall have a minimum 14 gauge 304 stainless steel shell/band, minimum 10 gauge 304 reinforced risers; minimum thickness of 0.090 EPDM or PVC interior liners, glass reinforces polymer or ultra high molecular weight polyethylene and 304 stainless bolts, nuts and washers.**						
		Advance Products	SSI8 / SSI12		SSI8 / SSI12		SSI8 / SSI12	
		BWM Company	BWM-SS-8 / SS-12		BWM-SS-8 / SS-12		BWM-SS-8 / SS-12	
		Cascade Water Works	Series CCS 8" / 12"		Series CCS 8" / 12"		Series CCS 8" / 12"	
		CCI Pipeline	Model CCS8 / CSS12		Model CCS8 / CSS12		Model CCS8 / CSS12	
		Pipeline Seal & Insulator, Inc (PSI)	Series S8G-2 / S12G-2		Series S8G-2 / S12G-2		Series S8G-2 / S12G-2	
Coatings	Exterior Coatings for Exposed Metal Assets	**Coatings: Aerial pipe, hydrants, above ground piping, fittings, valves and Appurtenances - System 1 Zinc / Urethane / Fluoropolymer application and color code per Section 3119 Coatings & Linings. Coating shall not be in contact with Potable water unless NSF 61 approved.**						
		Carboline	Carbozinc 621	3.0 - 8.0 mils	Carbozinc 621	3.0 - 8.0 mils	Carbozinc 621	3.0 - 8.0 mils
			Carbothane 133 HB	3.0 -5.0 mils	Carbothane 133 HB	3.0 -5.0 mils	Carbothane 133 HB	3.0 -5.0 mils
			Carboxane 950	2.0 - 3.0 mils	Carboxane 950	2.0 - 3.0 mils	Carboxane 950	2.0 - 3.0 mils
		Tnemec	Zinc Series 90-97	2.5 - 3.5 mils	Zinc Series 90-97	2.5 - 3.5 mils	Zinc Series 90-97	2.5 - 3.5 mils
			Typoxy Series 27WB	4.0 -14.0 mils	Typoxy Series 27WB	4.0 -14.0 mils	Typoxy Series 27WB	4.0 -14.0 mils
			EnduraShield Series73	2.0 - 3.0 mils	EnduraShield Series73	2.0 - 3.0 mils	EnduraShield Series73	2.0 - 3.0 mils
			Hydroflon Series 700	2.0 - 3.0 mils	Hydroflon Series 700	2.0 - 3.0 mils	Hydroflon Series 700	2.0 - 3.0 mils
	Exterior Coatings for Exposed Metal Assets	**Coatings: Aerial pipe, hydrants, above ground piping, fittings, valves and Appurtenances - System 2 Zinc / Epoxy / Urethane application and color code per Section 3119 Coatings & Linings. Coating shall not be in contact with Potable water unless NSF 61 approved.**						
		Carboline	Carbozinc 621	3.0 - 8.0 mils	Carbozinc 621	3.0 - 8.0 mils	Carbozinc 621	3.0 - 8.0 mils
			Carboguard 60	4.0 -6.0 mils	Carboguard 60	4.0 -6.0 mils	Carboguard 60	4.0 -6.0 mils
			Carboxane 950	2.0 - 3.0 mils	Carboxane 950	2.0 - 3.0 mils	Carboxane 950	2.0 - 3.0 mils
		Tnemec	Zinc Series 90-97	2.5 - 3.5 mils	Zinc Series 90-97	2.5 - 3.5 mils	Zinc Series 90-97	2.5 - 3.5 mils
			Typoxy Series 27WB	4.0 -14.0 mils	Typoxy Series 27WB	4.0 -14.0 mils	Typoxy Series 27WB	4.0 -14.0 mils
			Hi-Build Epoxoline II Series N69	4.0 - 10.0 mils	Hi-Build Epoxoline II Series N69	4.0 - 10.0 mils	Hi-Build Epoxoline II Series N69	4.0 - 10.0 mils
			EnduraShield Series73	2.0 - 3.0 mils	EnduraShield Series73	2.0 - 3.0 mils	EnduraShield Series73	2.0 - 3.0 mils
		PPG / Ameron	Amercoat 68HS	Min 3.0 mils	Amercoat 68HS	Min 3.0 mils	Amercoat 68HS	Min 3.0 mils
			Amercoat 385	4.0 - 6.0 mils	Amercoat 385	4.0 - 6.0 mils	Amercoat 385	4.0 - 6.0 mils
			Amercoat 450H	2.0 - 3.0 mils	Amercoat 450H	2.0 - 3.0 mils	Amercoat 450H	2.0 - 3.0 mils

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Fittings	Fittings	**Ductile Iron Fittings C153 SSB / C110 FLG: (Water & Reclaimed Water fittings shall cement lined or holiday free fusion bonded epoxy lined) (Wastewater fittings interior shall be Protecto 401 and holiday free)**						
		American	30" & up	FBE / Cement	30" & up	FBE / Cement	30" & up	Protecto 401
		Sigma		FBE / Cement		FBE / Cement		Protecto 401
		Star		FBE / Cement		FBE / Cement		Protecto 401
		Tyler Union & Clow		FBE / Cement		FBE / Cement		Protecto 401
Flow	Flow Meter	**Flow Meters With Replaceable Sensors**						
		EMCO	NA	NA	NA	NA	Unimag 4411E	
Hydrants	Hydrants	**Hydrants Shall open left, 1-1/2 Pentagon operating nut, NST hose & pumper thread, rotate 360 degrees, closed drains, epoxy on shoe in & out and 304 SS nuts & bolts below ground.**						
		American Flow Control	B-84-B (6 inch)		NA	NA	NA	NA
		Clow	Medallion 2545		NA	NA	NA	NA
		Mueller	Super Centurion 250		NA	NA	NA	NA
Joint Restraints	Ductile iron pipe MJ Restraints	**Mechanical Joint Wedge-action Restraining Gland, Epoxy Coated Restrain ductile iron pipe to mechanical joint fittings, pipe and appurtenances.**						
		EBAA Iron Inc	Megalug Series 1100		Megalug Series 1100		Megalug Series 1100	
		Ford / Uni-Flange	UFR-1400		UFR-1400		UFR-1400	
		Sigma	OneLok Series SLD/SLDE		OneLok Series SLD/SLDE		OneLok Series SLD/SLDE	
		Smith Blair	Cam Lok Series 111		Cam Lok Series 111		Cam Lok Series 111	
		Star	Star Grip Series 3000		Star Grip Series 3000		Star Grip Series 3000	
		Tyler Union	TufGrip Series TLD		TufGrip Series TLD		TufGrip Series TLD	
	DIP Bell Joint Restraints (4"-12") (New & Existing)	**Bell Joint Restraints for Ductile Iron Pipe (4"-12") (New & Existing) - All restraints split serrated on bell and spigot ends. Pipe 16" and greater shall have restraint gaskets or locking bells. (Wastewater only for restraint of existing DIP FM)**						
		EBAA Iron Inc	Tru-Dual Series 1500TD		Tru-Dual Series 1500TD		Tru-Dual Series 1500TD	
		Ford / Uni-Flange	Uni-Flange Series 1390C		Uni-Flange Series 1390C		Uni-Flange Series 1390C	
		Sigma	PV-Lok Series PWP-C		PV-Lok Series PWP-C		PV-Lok Series PWP-C	
		Smith Blair	Bell-Lock Series 165		Bell-Lock Series 165		Bell-Lock Series 165	
		Star	StarGrip Series 3100S		StarGrip Series 3100S		StarGrip Series 3100S	
		Tyler Union	TufGrip-Series 300C		TufGrip-Series 300C		TufGrip-Series 300C	
	DIP Bell Joint Restraints (16" & Greater)	**Ductile Iron Pipe Bell Joint Restraints for Ductile Iron Pipe (16" & Greater) - All restraints shall have a split back-up ring for the bell and a serrated or wedge action gland for the spigot end. New installation for water & reclaimed water piping 16" and greater shall have restraint gaskets or locking bells.**						
		EBAA Iron Inc	Series 1100HD	Existing Only	Series 1100HD	Existing Only	Series 1100HD	Existing Only
		Sigma	Series SSLDH	Existing Only	Series SSLDH	Existing Only	Series SSLDH	Existing Only
		Star	Series 3100S	Existing Only	Series 3100S	Existing Only	Series 3100S	Existing Only

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Joint Restraints	Ductile iron pipe Bell Joint Restraint Gaskets and Locking Bell (4" & Above)	**Bell Joint Restraint Gaskets and Locking Bell (4" & Above) Stainless Steel locking wedges built into the gasket-rubber. ANSI/AWWA C111/A21.11 Standard for Rubber-Gasket Joints for Ductile Iron Pressure Pipe. Ductile Iron Bell Joint Restraint for Push-On Pipe- Locking bell joint system that prevents joint separation and allows for joint deflection. Bells shall be painted red to verify restrained gasket.**						
		American	Fast Grip Gasket	Gasket	Fast Grip Gasket	Gasket	NA	NA
			Flex-Ring Joint	Bell Lock	Flex-Ring Joint	Bell Lock	NA	NA
			Lok-Ring Joint	Bell Lock	Lok-Ring Joint	Bell Lock	NA	NA
		Griffin	Talon RJ Gasket	Gasket	Talon RJ Gasket	Gasket	NA	NA
			Snap-Lok	Bell Lock	Snap-Lok	Bell Lock	NA	NA
		McWane Inc. DI Pipe Group	Sure Stop 350 Gasket	Gasket	Sure Stop 350 Gasket	Gasket	NA	NA
			Thrust-Lock	Bell Lock	Thrust-Lock	Bell Lock	NA	NA
			TR-Flex	Bell Lock	TR-Flex	Bell Lock	NA	NA
			Super-Lock	Bell Lock	Super-Lock	Bell Lock	NA	NA
		US Pipe	Field Lok 350 Gasket	Gasket	Field Lok 350 Gasket	Gasket	NA	NA
			Field Lok Gasket	Gasket	Field Lok Gasket	Gasket	NA	NA
			TR-Flex	Bell Lock	TR-Flex	Bell Lock	NA	NA
			HP Lok Restraint Joint	Bell Lock	HP Lok Restraint Joint	Bell Lock	NA	NA
	SS to DIP Transition Restraint	**SS to DIP Transition Restraint -Flanged stainless steel pipe from Wetwell to Valve box restrained joint transition (epoxy coated, SS hardware) Flg x PE RJ.**						
		EBAA Iron Inc	NA	NA	NA	NA	Megaflange 2100	
		Sigma	NA	NA	NA	NA	SigmaFlange with One Lock SLDE	
		Smith Blair	NA	NA	NA	NA	911 Flange - Lock Restrained FCA	
	PVC Pipe MJ Restraints	**Mechanical Joint Wedge-action Restraining Gland, Epoxy Coated Restrain PVC pipe to mechanical joint fittings, and appurtenances.**						
		EBAA Iron Inc	Mega-lug Series 2000PV		Mega-lug Series 2000PV		Mega-lug Series 2000PV	
			NA	NA	NA	NA	Megalug Series 2200	(42"-48")
		Ford / Uni-Flange	UFR 1500 Series		UFR 1500 Series		UFR 1500 Series	
		Sigma	One Lok Series SLC/SLCE		One Lok Series SLC/SLCE		One Lok Series SLC/SLCE	
		Smith Blair	Cam Lok Series 120		Cam Lok Series 120		Cam Lok Series 120	
		Star	Star Grip Series 4000		Star Grip Series 4000		Star Grip Series 4000	
		Tyler Union	TufGrip Series TLP		TufGrip Series TLP		TufGrip Series TLP	
	PVC Bell Joint Restraints (4" - 12") (New & Existing)	**PVC Bell Joint Restraints: PVC pipe Split Serrated on Bell End and Spigot End. (4" - 12") (New & Existing)**						
		EBAA Iron Inc	Tru-Dual Series 1500TD		Tru-Dual Series 1500TD		Tru-Dual Series 1500TD	
		Ford / Uni-Flange	Uni-Flange Series 1390		Uni-Flange Series 1390		Uni-Flange Series 1390	
		Sigma	PV-Lok Series PWP		PV-Lok Series PWP		PV-Lok Series PWP	
		Smith Blair	Bell-Lock Series 165		Bell-Lock Series 165		Bell-Lock Series 165	
		Star	Series 1100C		Series 1100C		Series 1100C	
		Tyler Union	TufGrip 300C		TufGrip 300C		TufGrip 300C	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Joint Restraints	PVC Bell Joint Restraints (16" & Greater)	**PVC Bell Joint Restraints: (16" & Greater) PVC pipe Split Serrated on Bell End and Spigot End. Water & Reclaimed Water Existing pipe only. Wastewater shall be new and existing pipe.**						
		Ford / Uni-Flange	Series 1390	Existing Only	Series 1390	Existing Only	Series 1390	
		JCM	Sur-Grip Series 621	Existing Only	Sur-Grip Series 621	Existing Only	Sur-Grip Series 621	
		Sigma	PV-Lok PWP	Existing Only	PV-Lok PWP	Existing Only	PV-Lok PWP	
		Smith Blair	Bell-Lock Series 165	Existing Only	Bell-Lock Series 165	Existing Only	Bell-Lock Series 165	
		Star	Series 1100C	Existing Only	Series 1100C	Existing Only	Series 1100C	
Pipe	PVC C900 DR 18 Bell & Spigot (4" - 12")	**C900 Bell & Spigot PVC Pipe: 4 to 12-inch - AWWA C-900, Minimum DR18 for Water, Reclaimed and Wastewater. DR14 for Fire Lines. Manufacturers shall be members in good standing with Uni-Bell to maintain approval status.**						
		Certainteed 4" to 12"	Certa-Lok C900/RJ	Blue	Certa-Lok C900/RJ	Pantone Purple	Certa-Lok C900/RJ	Green
		Diamond Plastics Corp	C-900	Blue	C-900	Pantone Purple	Diamond C900	Green
		Ipex Inc	C-900 Blue Brute	Blue	C-900	Pantone Purple	C900 Blue Brute	Green
		JM Eagle	C-900	Blue	C-900	Pantone Purple	C-900	Green
		National Pipe & Plastics Inc	C-900 Dura- Blue	Blue	C-900	Pantone Purple	C-900 Pipe	Green
		North American Pipe Corp (NAPCO)	C-900	Blue	C-900	Pantone Purple	C-900	Green
		Sanderson Pipe Corp	C-900	Blue	C-900	Pantone Purple	C-900	Green
	PVC C905 DR 18 Bell & Spigot 16" and Larger	**C905 Bell & Spigot PVC Pipe 16" and Larger: AWWA C-905, Minimum DR18 for all Force Mains up to 24". Minimum DR21/DR25 for 30" and greater. Manufacturers shall be members in good standing with Uni-Bell to maintain approval status.**						
		Certainteed 16"	NA	NA	NA	NA	Certa-Lok C905/RJ	NA
		Diamond Plastics Corp	NA	NA	NA	NA	Trans-21 DR18	Green
		Ipex Inc	NA	NA	NA	NA	IPEX Centurion	Green
		JM Eagle	NA	NA	NA	NA	C905 Big Blue	Green
		National Pipe & Plastics Inc	NA	NA	NA	NA	C905	Green
		North American Pipe Corp (NAPCO)	NA	NA	NA	NA	C905 Big Blue	Green
	HDPE C906 DR11	**HDPE Pipe DR11 AWWA C906 shall be Ductile Iron Pipe Size, PE 3408/3608/4710 DIPS manufactured in accordance with ASTM F-714 and listed with NSF. Pipe shall be marked in accordance with either AWWA C901,AWWA C906. Compression type connections are not acceptable in new installations. Pipe joints shall be butt fusion or electro-fusion with flange or adapter. All HDPE shall be color coded to the Utility. Color identifications are in accordance with the APWA/ULCC Uniform Color Code. Manufacturers shall be members in good standing with PPI to maintain approval status.**						
		JM Eagle	HDPE	DR11 Blue	HDPE	DR11 Pantone	HDPE	DR11Green
		Performance Pipe(Chevron)	Driscoplex 4000	DR11 Blue	Driscoplex 4000	DR11 Pantone	Driscoplex 4300	DR11 Green
		PolyPipe, Inc.	EHMW Poly Pipe	DR11 Blue	EHMW	DR11 Pantone	EHMW	DR11Green

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Pipe	Ductile Iron Pipe	**Ductile iron/Cast iron: (4" to 12" = Class 350, 16" to 24" - Class 250, 30" to 64" = Class 200). Water and Reclaimed water shall be cement lined. Wastewater Piping shall be Protecto 401 and Holiday Free. Exterior coatings as specified. Wastewater DIP piping shall be for pump station piping only. Manufacturers shall be members in good standing with DIPRA to maintain approval status.**						
		American	Cement Lined	Blue	Cement Lined	Pantone Purple	Protecto 401	Pump Station
		Griffin	Cement Lined	Blue	Cement Lined	Pantone Purple	Protecto 401	Pump Station
		McWane Inc. DI Pipe Group	Cement Lined	Blue	Cement Lined	Pantone Purple	Protecto 401	Pump Station
		US Pipe	Cement Lined	Blue	Cement Lined	Pantone Purple	Protecto 401	Pump Station
Sample	Sample Station	**Sample Stations - Bacteriological Sample Station with built in flush system, all internal piping to be 2", brass and includes lockable green enclosures.**						
		Safety-Guard	SG-BSS-05 pedestal #77	green enclosure	NA	NA	NA	NA
		Water Plus Corp	Model 5000	green	NA	NA	NA	NA
Services	Brass Service Saddles	**Brass Service Saddles for 1" & 2" water & reclaimed water services on 4" through 12" Mains - Service saddles can be hinge or bolt controlled OD saddles to be used on C-900 and existing IPS OD PVC pipe.**						
		Ford	Series S-70, S-90	4"-12"	Series S-70, S-90	4"-12"	NA	NA
		AY McDonald	Model 3891 / 3895,3801 / 3805	4"-12"	Model 3891 / 3895,3801 / 3805	4"-12"	NA	NA
		Mueller	Series S-13000/H-13000	4"-12"	Series S-13000/H-13000	4"-12"	NA	NA
	Service Saddles	**Service Saddles for 1" (CC) & 2" (Iron pipe threads) Water & Reclaimed Water services on mains greater than 12". Service saddles for 2" taps (iron pipe threads) on 4" mains and greater for Waste Water. : Epoxy or nylon coated stainless steel 18-8-type 304 double straps, controlled O.D. saddles to be used on C-900 / C905 or DI for all 1-in and -2in taps on pipes over 12in.**						
		Ford	Series FC202	16" & greater	Series FC202	16" & greater	Series FC202	4" & greater
		JCM	Series 406	16" & greater	Series 406	16" & greater	Series 406	4" & greater
		Mueller	DR2S	16" & greater	DR2S	16" & greater	DR2S	4" & greater
		Romac	Series 202NS	16" & greater	Series 202NS	16" & greater	Series 202NS	4" & greater
		Smith Blair	Series 317	16" & greater	Series 317	16" & greater	Series 317	4" & greater
	Service Saddles for HDPE	**Service Saddles for 1" (CC) & 2" (Iron Pipe threads) Water and Reclaimed Water Services: Epoxy or nylon coated stainless steel 18-8-type 304 double straps, controlled O.D. saddles to be used on HDPE for all 1-in and -2in taps. Taps to HDPE pipe shall be approved on a case by case basis.**						
		Ford	Series FCP202		Series FCP202		Series FCP202	
		Romac	Series 202N-H		Series 202N-H		Series 202N-H	
		Smith Blair	Series 317-1 for HDPE		Series 317-1 for HDPE		Series 317-1 for HDPE	
	Corporation Stops Ball Type	**Corporation Stops Ball Type (1-inch with AWWA taper C threads only/pack joint outlet for CTS) 2" Corporation Stop Ball Type shall be 2" MIP X FIP threads.**						
		Ford	FB1000, FB1700-7		FB1000, FB1700-7		FB1700-7	2" ARV
		AY McDonald	4701B-22, 3149B2		4701B-22, 3149B2		3149B2	2" ARV
		Mueller	P25008, B-20046		P25008, B-20046		B-20046	2" ARV

APPENDIX D **LIST OF APPROVED PRODUCTS - TRANSMISSION SYSTEMS** **FEBRUARY 11, 2011**

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Services	Curb Stops	**Curb Stops - Straight Valves: Ball type compression 2" cts O.D. tubing by 2" FIP**						
		Ford	B41-777W		B41-777W		NA	NA
		AY McDonald	6102W-22		6102W-22		NA	NA
		Mueller	P25172		P25172		NA	NA
	Curb Stops	**Curb Stops - Straight Valves: ball type compression x compression**						
		Ford	B44-444W		B44-444W		NA	NA
		AY McDonald	6100W-22		6100W-22		NA	NA
		Mueller	P25146		P25146		NA	NA
	PE tubing	**Polyethylene tubing: AWWA C901. UV protection (SDR-9) 1-inch and 2-inch only. PE 3408 / PE 4710**						
		Charter Plastics	Blue Ice		Lav Ice		NA	NA
		Endot	Endopure Blue		Endocore Lavender		NA	NA
		JM Eagle	Pure-Core		NA	NA	NA	NA
Tapping Sleeves and Valves	Line Stops	**Line Stops**						
		JCM						
		Romac						
		Smith Blair						
	Tapping Sleeves	**Tapping Sleeves: (Mechanical joint for taps on cast iron, ductile iron, PVC & AC pipe, including size on size) with stainless steel nuts and bolts.**						
		American Flow Control	Series 2800		Series 2800		Series 2800	
			Series 1004		Series 1004		Series 1004	
		Clow	Series F-5205	DIP/PVC	Series F-5205	DIP/PVC	Series F-5205	DIP/PVC
			Series F-5207	A/C Pipe	Series F-5207	A/C Pipe	Series F-5207	A/C Pipe
		JCM	Series 414	FBE	Series 414	FBE	Series 414	FBE
		Mueller	Series H-615	DIP/PVC	Series H-615	DIP/PVC	Series H-615	DIP/PVC
			Series H-619	A/C Pipe	Series H-619	A/C Pipe	Series H-619	A/C Pipe
		Smith Blair	Style 623	FBE	Style 623	FBE	Style 623	FBE
	Tapping Valves: 12" and smaller	**Tapping Valves: 12" and smaller - Tapping Valves shall be furnished with an alignment lip and installed in the vertical position for Water and Reclaim Water. Wastewater shall be installed horizontally and abandoned in the open position. Tapping valves shall be resilient seated only and meet the requirements of AWWA C509 or C515**						
		American Flow Control	Series 2500	Alignment Lip	Series 2500	Alignment Lip	Series 2500	Alignment Lip
		Clow	Series F-6114	Alignment Lip	Series F-6114	Alignment Lip	Series F-6114	Alignment Lip
		Mueller	Series T2360 (4"-12")	Alignment Lip	Series T2360 (4"-12")	Alignment Lip	Series T2360 (4"-12")	Alignment Lip

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Tapping Sleeves and Valves	Tapping Valves: 16" and Larger	**Tapping Valves: 16" and Larger - Tapping valves shall be furnished with an alignment lip and be installed in the vertical position for Water and Reclaimed Water. No tapping valve shall be installed horizontally for Water and Reclaim Water unless approved by the engineer. Tapping Valves 16" and larger AWWA C515 resilient seated only (16" and 24" no gearing required) above 24" shall be installed vertically with a spur gear actuator unless noted by the engineer. All tapping valves above 24" shall be furnished with NPT pipe plugs for flushing the tracks when valves are installed horizontally. Tapping valves for Wastewater shall be installed horizontally and abandoned in open position.**						
		American Flow Control	Series 2500	Alignment Lip & flushing port	Series 2500	Alignment Lip & flushing port	Series 2500	Alignment Lip & flushing port
		Clow	Series F-6114	Alignment Lip & flushing port	Series F-6114	Alignment Lip & flushing port	Series F-6114	Alignment Lip & flushing port
		Mueller	Series T2361 (14"&up)	Alignment Lip & flushing port	Series T2361 (14"&up)	Alignment Lip & flushing port	Series T2361 (14"&up)	Alignment Lip & flushing port
Valves	Butterfly Valve 42" and Above	**Butterfly Valves 42"and above. AWWA C504. Actuators input torques based on 150 psi valve pressure and 16 fps velocity with a maximum input of 80 ft-lb on 2" nuts and shall withstand 250 ft-lbs. Valve seats shall be leak-tight in both directions at 150 psi.**						
		Clow	Style #1450		Style #1450		NA	NA
		Dezurik	BAW		BAW		NA	NA
		Mueller / Pratt	LINSEAL III / Groundhog		LINSEAL III / Groundhog		NA	NA
	Check Valves	**Valves (Check) 4-inch and Larger (8 mil epoxy lined)**						
		American Flow Control	NA		NA		Series 600 or 50 line	
		Clow / M&H / Kennedy	NA		NA		106	
		Mueller	NA		NA		Series 2600	
	Gate Valves 4" - 12"	**Gate Valves 12" and smaller - resilient seated only AWWA C509 or C515. Valve seat shall be leak-tight in both directions at 150 psi.**						
		American Flow Control	Series 2500		Series 2500		NA	NA
		Clow	Series F-6100		Series F-6100		NA	NA
		Mueller	Series A-2360		Series A-2360		NA	NA
	Gate Valves (Vertical) 16" and Up	**Gate Valves 16" and larger (Vertical Installation) AWWA C515 resilient seated only (16" and 24" no gearing required) above 24" shall be installed vertically with a gear actuator unless noted by the engineer. Valve seat shall be leak-tight in both directions at 150 psi.**						
		American Flow Control	Series 2500		Series 2500		NA	NA
		Clow	Series F-6100		Series F-6100			
		Mueller	Series A-2361		Series A-2361		NA	NA

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Valves	Plug Valves	**Plug Valves - Bi-directional, MJ & Flanged (min. 8mil fusion bonded epoxy with stainless steel bolts), gear operator to be sized for rated pressure of the valve. Valves 4"-20" shall be 80% Full Port and valves 24" and greater shall be minimum of 70% full port. Valve shall be factory tested to minimium 100 PSI in both directions.**						
		Clow	NA	NA	NA	NA	F-5412 FLG	4" & up
			NA	NA	NA	NA	F-5413 MJ	4" & up
		Dezurik	NA	NA	NA	NA	Series PEF or PEC	4"& up
		Millikan / Pratt	NA	NA	NA	NA	Eccentric / Ballcentric	4"& up
		Val-Matic	NA	NA	NA	NA	5600 or 5800 (FLG)	4" & up
			NA	NA	NA	NA	5700 or 5900 (MJ)	4" & up
Valve Boxes	Valve Boxes with Locking Lids (Cast Iron)	**Two piece standard screw type Heavy Duty Valve Boxes with Locking Lids (Cast Iron) and type of service cast in heavy duty traffic lid (H20 loading) ASTM A48**						
		Bingham/Taylor	Series 4905	Box	NA	NA	Series 4905	Box
			4905-X	Extension	NA	NA	4905-X	Extension
			4904-L	Blue Water Locking Lid	NA	NA	4904-L	Green Sewer locking Lid
		Sigma	Series VB 261X-267X	Box	VB-25031LK-VB-2612	Box	Series VB 261X-267X	Box
			VB 6302	Extension	VB-6302	Extension	VB 6302	Extension
			VB 4650W	Blue Water Locking Lid	VB2503LK	Purple Square Locking Lid	VB 4650S	Green Sewer locking Lid
		Star	Series VB-0002	Box	NA	NA	Series VB-0002	Box
			VBEX 12-24S	Extension	NA	NA	VBEX 12-24S	Extension
			VBLIDLOCK	Blue Water Locking Lid	NA	NA	VBLIDLOCK	Green Sewer locking Lid
		Tyler Union	Series 6850	Box	NA	NA	Series 6850	Box
			58, 59, 60	Extension	NA	NA	58, 59, 60	Extension
			Locking Lid	Blue Water Locking Lid	NA	NA	Locking Lid	Green Sewer locking Lid
	Valve Box	**For mains equal to, or greater than, 16" diameter or equal to greater than 6' feet deep**						
		American Flow Control	# 2A - 9A Retrofit Valve Box Insert	Fit inside std valve boxes	NA		2A - 9A Retrofit Valve Box Insert	Green Sewer locking Lid
		Mueller Company	MVB050C thru MVB130C with Extension Stem MVB875 Guide Plate	Blue Water Locking Lid	MVB050CR thru MVB130CR with Extension Stem MVB875 Guide Plate	Purple Square Locking Reclaim Lid	MVB050C thru MVB130C with Extension Stem MVB875 Guide Plate	Green Sewer locking Lid

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Coatings	Anti-Graffiti Paint	**Block Walls-Anti-Graffiti Paint per Section 3119 Coatings & Linings**						
		American Building Restoration Products	NA	NA	NA	NA	Polyshield Graffiti Preventer for Unpainted Masonry Type B	Super Bio Strip or Strip it all
		Tnemec / Chemprobe	NA	NA	NA	NA	626 DUR A PEL	680 Mark A Way
		Professional Products of Kansas, Inc	NA	NA	NA	NA	Professional Water Seal & Anti-Graffitiant (PWS-15 Super Strength)	Professional Phase II Cleaner
	Coatings for Existing Manholes	**Rehabilitation corrosion protection system per Section 3119 Coatings & Linings. Interior coating for force main connections to existing concrete manholes only. New precast structures and existing pump stations shall be lined.**						
		CCI Spectrum, Inc	NA	NA	NA	NA	Spectrashield	min of 500 mils
		Kerneos Aluminate Technologies	NA	NA	NA	NA	Sewpercoat	1" (1000mil)
		Raven Lining System	NA	NA	NA	NA	Raven 155 Primer Raven 405	min 8 mils min 125 mils
		Sauereisen	NA	NA	NA	NA	210 Series Topcoat Glaze 210G	min 125 mils min 20 mils
		Tnemec	NA	NA	NA	NA	Series 434 Topcoat Glaze 435	min 125 mils 15-20 mils
PVC Pipe and fittings	Pipe SDR 35 Gravity Mains	**PVC Pipe for Gravity SDR26/SDR 35 (Green in color) ASTM-D034. Manufacturers shall be members in good standing with Uni-Bell to maintain approval status.**						
		Certainteed	NA	NA	NA	NA	Gravity Sewer Pipe	
		Diamond Plastics Corp	NA	NA	NA	NA	Sani-21 SDR-35	
		JM Eagle	NA	NA	NA	NA	Gravity Sewer	
		National Pipe & Plastics, Inc.	NA	NA	NA	NA	Ever-Green Sewer Pipe	
		North American Pipe Corp (NAPCO)	NA	NA	NA	NA	Gravity Sewer	
		Sanderson Pipe Corp	NA	NA	NA	NA	Gravity Sewer	
	Locate Balls	**Locating Marker Systems - Wastewater Locator balls placed at all sanitary sewer cleanouts**						
		3M	NA	NA	NA	NA	3M™ EMS 4" Extended Range 5' Ball Marker 1404-XR	
	Fittings SDR 35	**Fittings, Adapters and Plugs - Gravity PVC ASTM-D3034, Min SDR26/ SDR 35**						
		GPK Products, Inc.	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	
		Harrington Corporation (HARCO)	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	
		Multi Fittings Corp.	NA	NA	NA	NA	SDR26/SDR 35 Trench Tough Sewer Fittings	
		JM Eagle	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	
		Plastic Trends Inc	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	
		TIGRE USA, Inc.	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
PVC Pipe a	Flexible Pipe Connectors	**Flexible Pipe Connectors and Transitions**						
		Fernco	NA	NA	NA	NA	1002, 1051, 1056 Series	
		Indiana Seal	NA	NA	NA	NA	102, 151, 156 Series	
		Mission Rubber	NA	NA	NA	NA	MR02, MR51, MR 56 Series	
Precast Concrete Structures	MH Lids	**Frame and Cover**						
		USF Fabrication Inc.	NA	NA	NA	NA	USF 225-AS	
	Adj Ring	**Top Adjusting Rings - HDPE with heavy duty loading (H-20)**						
		Ladtech, Inc	NA	NA	NA	NA	24R, 24S with Rope Sealant CS2455	
	Hatches	**Wet Well and Valve Vault Access Frames and Covers (Include the term "Confined Space" etched or cast into the cover with recessed lock & hasp. Frames and covers per manufacturers specifications.**						
		Halliday Products	NA	NA	NA	NA	S1R or S2R Series	
		USF Fabrication Inc.	NA	NA	NA	NA	APS or APD Series	
	Precast Concrete Structures	**Precast Manhole and Wetwell Structures ASTM C478. Precast concrete shall be batched with concrete dyed crystalline waterproofing admixture with corrosion protection. Concrete without admixture or without color tint /tracer shall be rejected.**						
		Allied Precast	NA	NA	NA	NA		Dyed Admix
		Atlantic Concrete Products, Inc.	NA	NA	NA	NA		Dyed Admix
		Delzotto Products, Inc.	NA	NA	NA	NA		Dyed Admix
		Dura Stress Underground Inc.	NA	NA	NA	NA		Dyed Admix
		Hanson Pipe & Product	NA	NA	NA	NA		Dyed Admix
		Mack Concrete	NA	NA	NA	NA		Dyed Admix
		Oldcastle Precast	NA	NA	NA	NA		Dyed Admix
		Standard Precast Inc.	NA	NA	NA	NA		Dyed Admix
	Concrete Admix	**Crystalline Waterproofing Concrete Admix with color dye shall be added to all concrete structures (precast and cast-in-place) to provide waterproofing and corrosion resistance. Concrete without admixture or without color tint / tracer shall be rejected. % concentration of admix with colored dye added to the mix shall be based on weight of cement.**						
		Kryton International	NA	NA	NA	NA	KIM K-301R (with red dye)	2%
		Xypex Chemical Corp	NA	NA	NA	NA	Xypex Admix C-1000Red (with red dye)	3.0 - 3.5%
	Liners	**Interior Liner for New or existing Precast Manhole and Precast Wetwell Structures per Section 3119 Coatings & Linings**						
		AFE	NA	NA	NA	NA	Fiberglass Liner	
		AGRU Liner	NA	NA	NA	NA	HDPE Liner (Min 2 mm for Manhole / Min 5 mm for Pump Station)	
		Containment Solutions Inc. (Flowtite)	NA	NA	NA	NA	Fiberglass Liner	
		GSE Studliner	NA	NA	NA	NA	HDPE Liner (Min 2 mm for Manhole / Min 5 mm for Pump Station)	
		GU Liner	NA	NA	NA	NA	Reinforced Plastic Liner	
		L & F Manufacturing	NA	NA	NA	NA	Fiberglass Liner	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Precast Concrete Structures	Heat Shrink Seal	**Heat Shrink Seal - Precast structures shall be primed with manufacturer approved primer prior to application of heat shrunk encapsulation.**						
		Canusa-CPS	NA	NA	NA	NA	Wrapid Seal with WrapidSeal Primer (Canusa G Primer)	
		Pipeline Seal & Insulator, Inc (PSI)	NA	NA	NA	NA	Riser Wrap with Polyken 1027 or 1039 primer	
	Jointing Material	**Jointing Material Min. 2" width for all products to ensure squeeze out with manufacturer approved primer.**						
		Henry Company	NA	NA	NA	NA	Ram-Nek	with Primer
		Martin Asphalt Company	NA	NA	NA	NA	Evergrip 990	with Primer
		Trelleborg Pipe Seals	NA	NA	NA	NA	NPC – Bidco C-56	with Primer
	Pipe Seals Gravity	**Resilient Connector Pipe Seals, Manhole - Gravity less than 12-inch and less than 15-ft deep**						
		Atlantic Concrete	NA	NA	NA	NA	A-Lok (cast-in-place)	
		Hail Mary Rubber	NA	NA	NA	NA	Star Seal (cast-in-place)	
		IPS	NA	NA	NA	NA	Wedge Style	
		NPC	NA	NA	NA	NA	Kor-N-Seal Model WS	
		Press seal gasket	NA	NA	NA	NA	PSX Direct Drive	
	Pipe Seals Gravity	**Cast in Place Pipe Seals, Manhole - Gravity Greater Than or Equal to 12-inch and all pipe sizes greater than 15-ft deep**						
		Atlantic Concrete	NA	NA	NA	NA	A-Lok	cast in place
		Hail Mary Rubber	NA	NA	NA	NA	Star Seal	cast in place
	FM Pipe Seals	**Modular Pipe Seals for Wet Well and Valve Box penetrations and all forcemain connections to existing and new precast concrete structures. EPDM Rubber with 316 SS Hardware**						
		CCI Pipeline Systems	NA	NA	NA	NA	Wrap-It Link WL-SS Series	
		Pipeline Seal & Insulator, Inc / Link Seal	NA	NA	NA	NA	Link-Seal S-316 Modular Seal	
		Proco Products, Inc	NA	NA	NA	NA	PenSeal ES-PS Series	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Generator	Gen	**Generator Systems, Fixed Shall be UL 2200 Certified.**						
		Caterpillar	NA	NA	NA	NA	CAT Diesel Generator Set	
		Cummins Power Generation	NA	NA	NA	NA	Diesel Generator Set	
	Fuel Tanks	**Generator Fuel Tanks. Shall be UL2085 certified.**						
		Convault	NA	NA	NA	NA	CVT-3SF or CVT-3FF	
		Phoenix	NA	NA	NA	NA	Envirovault	
	GR	**Generator Receptacle (GR)**						
		Cooper Crouse-Hinds	NA	NA	NA	NA	AR2042 (230V, 200A, 3P, 4W)	With AJA1 Angle Adaptor
		Cooper Crouse-Hinds	NA	NA	NA	NA	AR2042-S22 (460V, 200A, 3P, 4W)	With AJA1 Angle Adaptor
		Pyle National	NA	NA	NA	NA	JRE-4100 (230V, 100A, 3P, 4W)	
	ATS	**Generator Transfer Switch**						
		Russelectric	NA	NA	NA	NA	RMTD Series with model 2000 controller	NEMA 12/3R 316SS Enclosure
Odor Control Units	Biotrickling Filters	**Biotrickling filters**						
		BioAir	NA	NA	NA	NA		
		Biorem	NA	NA	NA	NA	Biosorbens BTF	
		Envirogen	NA	NA	NA	NA	BTF	
		Siemens	NA	NA	NA	NA	Zabocs BTF	
	Carbon Adsorption Units	**Carbon Adsorption Units**						
		Calgon	NA	NA	NA	NA		
		Pure Air Filtration	NA	NA	NA	NA		
		Siemens	NA	NA	NA	NA		
Pressure Gauges	Pressure Gauges	**Pressure Gauges shall have Diaphragm Seals. Oil filled.**						
		Ashcroft	NA	NA	NA	NA	10 1008SL 02L 60# 25 200SS 02T XYTSE	Gauge Diaphragm Seal
		Trerice	NA	NA	NA	NA	D83LFSS4002LA100 - Gauge M51001SSSS - Diaphragm Seal D99100 Fill and Mount Charge	
		Winter Gauges	NA	NA	NA	NA	PFQ770 0-60 PSI D70950 top D70954 Bottom	
Pumps	Pumps	**Submersible Pumps**						
		ABS	NA	NA	NA	NA		
		Flygt	NA	NA	NA	NA		

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Pumps	Floats	**Float Regulator (FR) - Duplex and Triplex Pump Stations**						
		Atlantic Scientific	NA	NA	NA	NA		Roto-Float
	Radar	**Radar - Pulse Burst Radar Transmitter. Input 24 VDC and Output 4-20 mA**						
		Magnetrol	NA	NA	NA	NA		R82-520A-011
Pump Station Main Ser	Main Srvc Disconne	**Main Service Disconnect Breaker**						
		Square D	NA	NA	NA	NA		H or J Frame 3 Pole 600 Volt (HGL or JGL determined by amperage)
	Surge Protector Device	**Surge Protector - UL 1449, 3rd Edition listed and labeled, minimum 10 year warranty, NEMA LS-1 and IEEEC62, 41/45 tested with NEMA 4X enclosure, internal fusing, voltage and phase to match service. Rated 80,000 amps per mode for Duplex & Triplex stations and 150,000 Amperes per mode for Master Stations. All devices shall be provided with a NEMA 4X Plastic enclosure which is approved in lieu of stainless steel.**						
		Current Technology (Power & Systems	NA	NA	NA	NA		XN-80, TG-150 or CurrentGuard 150 Plus Series
		Josyln AKA (Total Protection Solutions)	NA	NA	NA	NA		TSS-ST 160 Series, ST 300 Series or JSP-300 Series
		Surge Suppressors, Inc	NA	NA	NA	NA		LSE Series or SHL Series
Sub Panel	Sub Panel	**Sub-Panel Enclosure - NEMA 12/3R Enclosure 316SS, white polyester Powder coated-finish inside and out, With 3 Point Pad lockable Handle, and Door Stop**						
		Hoffman	NA	NA	NA	NA		
		Schaefer	NA	NA	NA	NA		
		Universal enclosure systems	NA	NA	NA	NA		
Pump Station Control Panel	Control Panel	**Control Panel Supplier**						
		ECS	NA	NA	NA	NA		
		Sta-Con Inc	NA	NA	NA	NA		
	Enclosure	**Enclosure - NEMA 12/3R Enclosure 316SS, white polyester Powder coated finish inside and out, With 3 Point Pad lockable Handle, and Door Stop**						
		Hoffman	NA	NA	NA	NA		
		Schaefer	NA	NA	NA	NA		
		Universal enclosure systems	NA	NA	NA	NA		
	Mnts	**Mounting Channel for Enclosures**						
		Unistrut Stainless Steel	NA	NA	NA	NA		1" 5/8 x 1" 5/8 316 SS
	Seal-off	**Explosion-Proof Sealoff**						
		Cooper Crouse-Hinds	NA	NA	NA	NA		EYSR - 2 Inch Min.
	FL	**Flasher (FL)**						
		MPE	NA	NA	NA	NA		025-120-105
		SSAC	NA	NA	NA	NA		FS-126

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Pump Station Control Panel	AL	**Alarm Light / With Base and Globe (AL)**						
		American Electric	NA	NA	NA	NA	F32552	
		Red Dot Globe	NA	NA	NA	NA	VGLR-01	
		Red Dot Base					VA-01	
	AH	**Alarm Horn (AH)**						
		Wheelock	NA	NA	NA	NA	3IT-115-R	
	Fuse	**Fuses (F)**						
		Bussmann	NA	NA	NA	NA	FNQ-R or KTK-R	
	HOA	**Hand-Auto-Off Selector (HOA)**						
		Square D	NA	NA	NA	NA	9001-SKS43B	
	HSS	**Horn Silence Button (HSS)**						
		Square D	NA	NA	NA	NA	9001-SKR1RH5	
	Inter-lock	**Mechanical Interlock**						
		Square D	NA	NA	NA	NA	S29354	
	Breakers	**Control Panel Main Circuit Breaker (MCB) With S29450 Circuit Breaker Auxiliary Switch**						
		Square D	NA	NA	NA	NA	H or J Frame 3 Pole 600 Volt (HGL or JGL determined by amperage)	
		Emergency Circuit Breaker (ECB) With S29450 Circuit Breaker Auxiliary Switch						
		Square D	NA	NA	NA	NA	H or J Frame 3 Pole 600 Volt (HGL or JGL determined by amperage)	
		Motor Circuit Breaker (MB)						
		Square D	NA	NA	NA	NA	H or J Frame 3 Pole 600 Volt (HGL or JGL determined by amperage)	
		Control Circuit Breaker/ GFCI Receptacle Breaker/ SCADA Breaker						
		Square D	NA	NA	NA	NA	QOU120	
	MS	**Motor Starter (MS)**						
		Square D	NA	NA	NA	NA	Type S Class 8536	
	OL	**Overload Heater(OL)**						
		Square D	NA	NA	NA	NA	Part number will vary with size needed	
	OR	**Overload Reset**						
		Square D	NA	NA	NA	NA	9066-RA1	
	Transformer	**Control Circuit Transformer (XMFR)**						
		Square D	NA	NA	NA	NA	9070TF75D23	120/24 Volt .075 KVA
		Main Circuit Transformer (MCT)						
		Square D	NA	NA	NA	NA	9070T2000D1	480/120 2KVA
	SPB	**Supplemental Protector Breaker - 3 pole, 1-amp for Phase Monitor**						
		Square D	NA	NA	NA	NA	MG24532	

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater	
			Model #	Comments	Model #	Comments	Model #	Comments
Pump Station Control Panel	PM	**Phase Monitor (PM)**						
		MPE 240 V.	NA	NA	NA	NA	001-230-118-OVG5	
		MPE 480 V.	NA	NA	NA	NA	002-480-123-OVG5	
	Pump Alternator	**Pump Automatic Alternator (PAA)**						
		Diversified Duplex	NA	NA	NA	NA	ARA-120-ACA	
		Diversified Triplex	NA	NA	NA	NA	ARA-120-AME	
		MPE Duplex	NA	NA	NA	NA	008-120-13SP	
		MPE Triplex	NA	NA	NA	NA	009-120-23P	
		MPE Triplex Socket	NA	NA	NA	NA	SD-12-PC	
	Alt. Test Switch	**Alt. Test Switch**						
		Carling Technologies	NA	NA	NA	NA	6GG5E-78	
		Honeywell	NA	NA	NA	NA	2TL1-50	
	Relay	**Relay**						
		Potter Brumfield 24 Volt	NA	NA	NA	NA	KRPA-11AN-24	
		Potter Brumfield 120 Volt	NA	NA	NA	NA	KRPA-11AN-120	
		Square D 24 Volt	NA	NA	NA	NA	8501KP12P14V14	
		Square D 120Volt	NA	NA	NA	NA	8501KP12P14V20	
	Relay Base	**Relay Base**						
		IEDC 8 Pin Relay Base 600 Volt	NA	NA	NA	NA	SR2P-06	
	Duplex Receptacle / GFCI	**Duplex Receptacle/GFCI (DR) Upgraded to 20 Amp**						
		Hubbell	NA	NA	NA	NA	GFTR20BK	
		Pass & Seymour	NA	NA	NA	NA	2095TRBK	
	ETM	**Elapse Time Meter (ETM)**						
		Reddington	NA	NA	NA	NA	711-0160	
	Grounding	**Grounding System**						
		Marathon	NA	NA	NA	NA	Neutral Isolation Block 1421570	
		Panduit	NA	NA	NA	NA	Ground Lug LAM2A 1/0 - 014 -6Y	
		Square D	NA	NA	NA	NA	Ground Buss PK7GTA	
	TS	**Terminal Strip (TS)**						
		Marathon	NA	NA	NA	NA	Series 200	
		Square D	NA	NA	NA	NA	9080GR6	
	TS	**Terminal Strip End Blocks and End Clamps**						
		Square D	NA	NA	NA	NA	9080GM6B & 9080GH10	

APPENDIX D **LIST OF APPROVED PRODUCTS - PUMP STATION SYSTEMS** **FEBRUARY 11, 2011**

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Pump Station Control Panel	PL	**Pilot Light (PL) 24 Volt with 1819 Bulb**						
		Dialight	NA	NA	NA	NA	803-1710	
		Lighting Components & Design	NA	NA	NA	NA	Littlelight 930507X	
	RL	**Run Indicator Light (RL) 120 Volt**						
		Dialight	NA	NA	NA	NA	803-1710	
		Lighting Components & Design	NA	NA	NA	NA	Littlelites 930507X With 120MB Bulb	
	MT	**Moisture and Temperature Failure Light (MT) 120 Volt with 120MB Bulb**						
		Dialight	NA	NA	NA	NA	803-1710	
		Lighting Components & Design	NA	NA	NA	NA	Littlelites 930507X	
Sluice	Sluice Gate	**Sluice Gate for Wet Well with Motorized Operator**						
		BNW	NA	NA	NA	NA	Model 77 - 316 SS	
		Fontaine	NA	NA	NA	NA	Model 20 - 316 SS	
VFD	VFD	**Variable Frequency Drives**						
		Square D	NA	NA	NA	NA		