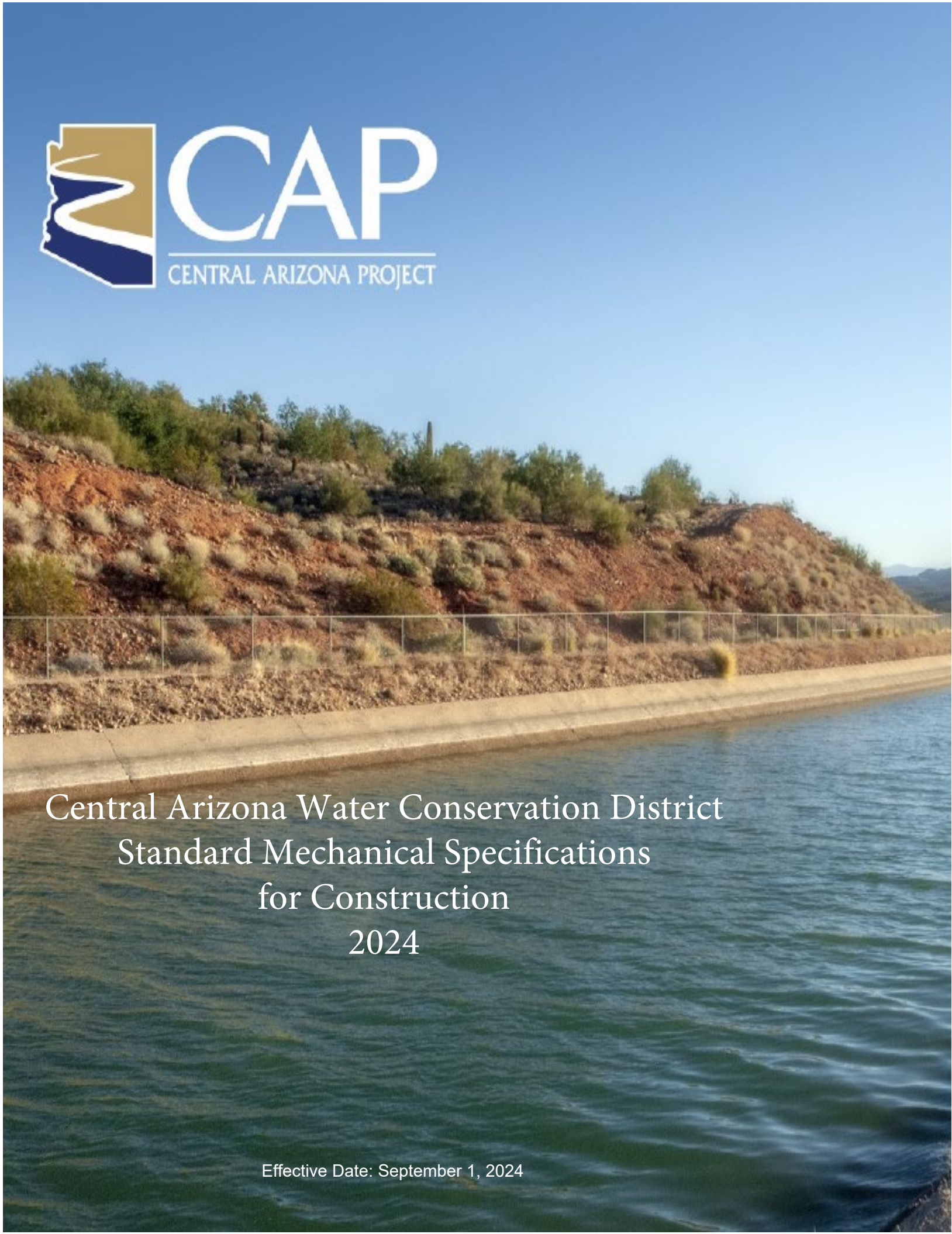


Central Arizona Water Conservation District Standard Mechanical Specifications for Construction 2024

Effective Date: September 1, 2024

Table of Contents

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Manufactured units for the following applications:

1. Roof curbs.
2. Equipment supports.
3. Roof hatches.
4. Pipe and duct supports.
5. Pipe portals.
6. Preformed flashing sleeves.
7. Roof walkways.
8. Miscellaneous materials.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of roof accessory.

B. Shop Drawings (SD):

1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items, including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof accessories in contact with other materials that might cause staining, denting, or other surface damage. Store roof accessories in accordance with manufacturer's instructions.

B. Store materials off ground in dry location and in accordance with manufacturer's instructions in well-ventilated area.

C. Store and protect roof accessories from nicks, scratches, and blemishes.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify profiles and tolerances of roof-accessory substrates by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Wind-Restraint Performance: As indicated on Drawings.

2.2 ROOF CURBS

A. Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, integral metal cant, stepped integral metal cant to raise the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.

B. Manufacturers: Subject to compliance with requirements, provide products by the same manufacturer as the associated equipment to be installed.

C. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

D. Supported Load Capacity: Coordinate load capacity with information on Shop Drawings of equipment to be supported.

E. Steel: Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet, minimum 0.052-inch thick.

1. Finish: Mill phosphatized, factory prime coating, or powder coat. Coordinate finish with CAWCD for approval prior to ordering.
2. Powder Coat Color: As selected by CAWCD from manufacturer's full range.

F. Aluminum: minimum 0.090-inch-thick sheet.

1. Finish: Mill phosphatized, factory prime coating, or powder coat. Coordinate finish with CAWCD for approval prior to ordering.
2. Powder Coat Color: As selected by CAWCD from manufacturer's full range.

G. Stainless Steel: minimum 0.0781-inch-thick sheet.

1. Finish: Manufacturer's standard.

H. Construction:

1. Curb Profile: Manufacturer's standard compatible with roofing system.
2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
3. Fabricate curbs to minimum height of 12-inches above roofing surface unless otherwise indicated.
4. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.
5. Sloping Roofs: Where roof slope exceeds 1/4-inch per 12 inches, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
6. Insulation: Factory insulated with minimum 1-1/2-inch-thick glass-fiber board insulation.
7. Liner: Same material as curb, of manufacturer's standard thickness and finish.
8. Nailer: Factory-installed wood nailer, continuous around curb perimeter.
9. Wind-Restraint Straps and Base Flange Attachment: Provide wind-restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to comply with wind-uplift requirements.
10. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
11. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.
12. Security Grille: Provide where indicated on drawings.
13. Damper Tray: Provide damper tray or shelf with opening of size indicated on drawings.

2.3 EQUIPMENT SUPPORTS

A. Internally reinforced perimeter or rail-type metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between

structural supports; capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, integral metal cant, stepped integral metal cant to raise the thickness of roof insulation, and integrally formed structure-mounting flange at bottom.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Supported Load Capacity: Coordinate load capacity with information on Shop Drawings of equipment to be supported.

D. Steel: Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet, minimum 0.052-inch thick.

    1. Finish: Mill phosphatized, factory prime coating, or powder coat. Coordinate finish with CAWCD for approval prior to ordering.
    2. Powder Coat Color: As selected by CAWCD from manufacturer's full range.

E. Aluminum: minimum 0.090-inch-thick sheet.

    1. Finish: Mill phosphatized, factory prime coating, or powder coat. Coordinate finish with CAWCD for approval prior to ordering.
    2. Powder Coat Color: As selected by CAWCD from manufacturer's full range.

F. Stainless Steel: minimum 0.0781-inch-thick sheet.

    1. Finish: Manufacturer's standard.

G. Construction:

    1. Curb Profile: Manufacturer's standard compatible with roofing system.
    2. Insulation: Factory insulated with minimum 1-1/2-inch-thick glass-fiber board insulation.
    3. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
    4. Nailer: Factory-installed continuous wood nailers minimum 3-1/2 inches wide, continuous around support perimeter.
    5. Wind-Restraint Straps and Base Flange Attachment: Provide wind-restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to comply with wind-uplift requirements.
    6. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
    7. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
    8. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
    9. Fabricate equipment supports to minimum height of 12 inches above roofing surface unless otherwise indicated.
    10. Sloping Roofs: Where roof slope exceeds 1/4 inch per 12 inches, fabricate each support with height to accommodate roof slope so that tops of supports are level

with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

11. Security Grille: Provide where indicated on Drawings.

2.4 ROOF HATCHES

A. Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, straight sides, integral metal cant, stepped integral metal cant to raise the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.

B. Type and Size:

1. Single-leaf lid, size as indicated on Drawings.
2. Double-leaf lid, size as indicated on Drawings.

C. Loads: Minimum 40 lbf/sq. ft. external live load and 20 lbf/sq. ft**.** internal uplift load.

D. Hatch Material, Steel: Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet.

1. Thickness: Manufacturer's standard thickness for hatch size indicated.
2. Finish: Mill phosphatized, factory prime coating, or powder coat. Coordinate finish with CAWCD for approval prior to ordering.
3. Powder Coat Color: As selected by CAWCD from manufacturer's full range.

E. Hatch Material, Aluminum:

1. Thickness: Manufacturer's standard thickness for hatch size indicated.
2. Finish: Mill phosphatized, factory prime coating, or powder coat. Coordinate finish with CAWCD for approval prior to ordering.
3. Powder Coat Color: As selected by CAWCD from manufacturer's full range.

F. Hatch Material, Stainless Steel:

1. Thickness: Manufacturer's standard thickness for hatch size indicated.
2. Finish: Manufacturer's standard.
3. Finish: Manufacturer’s standard.

G. Construction:

1. Insulation: minimum 1-inch thick, glass-fiber board.

    a. R-Value: minimum 4.3 in accordance with ASTM C1363.

2. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
3. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.

5. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
6. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
7. Sloping Roofs: Where slope or roof deck exceeds 1/4 inch per 12 inches, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.

H. Hardware: Spring operators, hold-open arm, galvanized steel spring latch with turn handles, galvanized steel butt- or pintle-type hinge system, and padlock hasps inside and outside.

1. Provide two-point latch on lids larger than 84 inches.

I. Safety Railing System: Roof-hatch manufacturer's standard system, including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.

1. Height: Minimum 42 inches above finished roof deck.
2. Posts and Rails: Galvanized-steel pipe, 1-1/4 inches in diameter or galvanized-steel tube, 1-5/8 inches in diameter.
3. Flat Bar: Galvanized steel, 2 inches high by 3/8 -inch thick.
4. Maximum Opening Size: System constructed to prevent passage of a sphere 21 inches in diameter.
5. Chain Passway Barrier: Galvanized proof coil chain with quick link on fixed end.
6. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
7. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
8. Provide weep holes or another means to drain-entrapped water in hollow sections of handrail and railing members.
9. Fabricate joints exposed to weather to be watertight.
10. Fasteners: Manufacturer's standard, finished to match railing system.
11. Finish: Manufacturer's standard.

a. Color: As selected by CAWCD from manufacturer's full range.

J. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.

1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
2. Height: 42 inches above finished roof deck.
3. Material: Steel tube.
4. Post: Minimum 1-5/8-inch diameter pipe.
5. Finish: Manufacturer's standard.

a. Color: As selected by CAWCD from manufacturer's full range.

2.5 PIPE AND DUCT SUPPORTS

A. Fixed-Height Cradle-Type Pipe Supports: Polycarbonate pipe stand accommodating up to 1-1/2-inch diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

B. Fixed-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand with polycarbonate roller carrying assembly accommodating up to 7-inch diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

C. Adjustable-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand base, pipe support, and roller housing, with stainless steel threaded rod designed for adjusting support height, accommodating up to 18-inch diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

D. Adjustable-Height Structure-Mounted Pipe Supports: Extruded-aluminum tube, filled with urethane insulation; 2 inches in diameter; accommodating up to 7-inch diameter pipe or conduit, with provision for pipe retainer; with aluminum baseplate, EPDM base seal, manufacturer's recommended hardware for mounting to structure or structural roof deck as indicated, stainless steel roller and retainer, and extruded-aluminum carrier assemblies; as required for quantity of pipe runs and sizes.

E. Curb-Mounted Pipe Supports: Galvanized-steel support with welded or mechanically fastened and sealed corner joints, straight sides, integral metal cant, stepped integral metal cant to raise the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom; with adjustable-height roller-bearing pipe support accommodating up to 20-inch diameter pipe or conduit and with provision for pipe retainer; as required for quantity of pipe runs and sizes.

F. Duct Supports: Extruded-aluminum, urethane-insulated supports, 2 inches in diameter; with manufacturer's recommended hardware for mounting to structure or structural roof deck.

    1. Finish: Manufacturer's standard.

2.6 PIPE PORTALS

A. Curb-Mounted Pipe Portal: Insulated roof-curb units with welded or mechanically fastened and sealed corner joints, straight sides, integral metal cant, stepped integral metal cant to raise the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom; with weathertight curb cover with single or multiple collared openings and pressure-sealed conically shaped EPDM protective rubber caps sized for piping indicated, with stainless steel snaplock swivel clamps.

B. Flashing Pipe Portal: Formed aluminum membrane-mounting flashing flange and sleeve with collared opening and pressure-sealed conically shaped EPDM protective rubber cap sized for piping indicated, with stainless steel snaplock swivel clamps.

2.7 PREFORMED FLASHING SLEEVES

A. Exhaust Vent Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, 12 inches high, with removable metal hood and slotted or perforated metal collar.

1. Metal: Aluminum sheet, minimum 0.063 -inch thick.
2. Diameter: As indicated on Drawings.
3. Finish: Manufacturer's standard,

B. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.

1. Metal: Aluminum sheet, minimum 0.063 -inch thick
2. Height: Minimum 7 inches.
3. Diameter: As indicated on Drawings.
4. Finish: Manufacturer's standard.

2.8 ROOF WALKWAYS

A. Roof Walkway: Metal planking formed from multiple C-shaped channels with upper surface punched in serrated diamond or rectangular shapes to produce raised slip-resistant surface and drainage holes. Provide support framing, brackets, connectors, nosings, and other accessories and components needed for complete installation.

1. Include step units or stairs of similar construction for changes in elevation. Comply with ASCE/SEI 7, 29 CFR 1910.23, and requirements of authorities having jurisdiction.
2. Equip walkways with safety railings where required.
3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Atkore Unistrut
    b. B-Line; a division of Eaton, Electrical Sector
    c. MIRO Industries Inc.
    d. PHP Systems/Design

4. Plank Width: As indicated on Drawings.
5. Walkway Width: As indicated on Drawings.
6. Channel Depth: As indicated on Drawings.
7. Metal Material: minimum 0.079-inch-thick zinc-coated (galvanized) steel sheet or minimum 0.080-inch thick aluminum sheet, perforated, with serrated slip-resistant walking surface.
8. Support Stands: Manufacturer's standard, with protective pads compatible with roofing material.
9. Support Pads: Continuous wood isolation pads, pressure-preservative treated as specified in Section 061000 "Rough Carpentry"; attach roof-walkway supports to

pads so that supports are separated from roof membrane surface and walkway support loads are distributed evenly.
10. Wind Restraint: Provide wind-restraint attachment to roof structure of size and spacing required to comply with wind-uplift requirements.
11. Finish: Manufacturer's standard.

2.9 METAL MATERIALS

A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheer complying with minimum ASTM A653/A653M, G90 coating designation or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, Class AZ50 coating designation; structural quality.

1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
3. Powder Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

B. Aluminum Sheet: ASTM B209/B209M, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

1. Mill Finish: As manufactured.
2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
3. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
4. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
5. Powder Coat Finish: AAMA 2603. After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
6. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

C. Aluminum Extrusions and Tubes: ASTM B221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

D. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.

E. Steel Shapes: ASTM A36/A36M, hot-dip galvanized in accordance with ASTM A123/A123M unless otherwise indicated.

F. Steel Tube: ASTM A500/A500M, round tube.

G. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized in accordance with ASTM A123/A123M.

H. Steel Pipe: ASTM A53/A53M, galvanized.

2.10 UNDERLAYMENT

A. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

B. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

2.11 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 1, thickness as indicated.

C. Glass-Fiber Board Insulation: ASTM C726, nominal density of 3 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F, thickness as indicated.

D. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

E. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.

F. Security Grilles: ASTM A1011/A1011M steel bars spaced maximum 6 inches o.c. in one direction and maximum 12 inches o.c. in the other; factory finished as follows:

1. Surface Preparation: Remove mill scale and rust, if any, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
3. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, universal primer; selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats under prolonged exposure.

G. Fasteners: Roof accessory manufacturer's recommended fasteners, designed to comply with performance requirements, suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

1. Fasteners for Metallic-Coated Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

H. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

I. Elastomeric Sealant: ASTM C920, elastomeric polyurethane or silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

J. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

K. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

L. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.12 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA AMP 500, "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

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

3.2 INSTALLATION, GENERAL

A. Install roof accessories in accordance with manufacturer's written instructions.

1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended in writing by manufacturer's written installation instructions.

1. Coat concealed side of uncoated aluminum and stainless steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

3.3 INSTALLATION OF ROOF ACCESSORIES

A. Roof Curb: Install each roof curb so top surface is level.

B. Equipment Support: Install equipment supports so top surfaces are level with each other.

C. Roof-Hatch:

1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attach safety railing system to roof-hatch curb.
3. Attach ladder-assist post in accordance with manufacturer's written instructions.

D. Pipe and Duct Support: Comply with MSS SP-58. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping, and support together.

1. Pipes of Various Sizes: Space supports for smallest pipe size or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.

E. Preformed Flashing-Sleeve and Flashing-Pipe Portal: Secure flashing sleeve to roof membrane in accordance with flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane in accordance with roof membrane manufacturer's instructions.

F. Security Grilles: Weld bar intersections and, using tamper-resistant bolts, attach the ends of bars to structural frame or primary curb walls.

G. Roof Walkway:

1. Verify that locations of access and servicing points for roof-mounted equipment are served by locations of roof walkways.
2. Remove ballast from top surface of low-slope roofing at locations of contact with roof-walkway supports.
3. Install roof-walkway support pads prior to placement of roof-walkway support stands onto low-slope roofing.
4. Redistribute removed ballast after installation of support pads.

H. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.4 CLEANING AND PROTECTION

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing in accordance with ASTM A780/A780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting.

C. On completion of installation, clean exposed surfaces in accordance with manufacturer's written instructions. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as roof accessories are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof accessories in a clean condition during construction.

E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 077200

SECTION 078400 - FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Firestopping through-penetrations of fire rated assemblies.

1.2 ACTION SUBMITTALS

A. Product Data (PD): For each type of product indicated.

1. Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design system numbers to seal openings or joints to maintain fire resistance rating of adjacent assembly.
2. Manufacturer's Installation Instructions: Submit preparation and installation instructions.
3. Engineering Judgements: For conditions not covered by UL listed designs, submit judgements by licensed professional engineer or product manufacturer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

B. Qualification Data: For qualified Installer.

C. Shop Drawings: Manufacturer-specific UL listed firestopping penetration details for each type of penetration on the project.

1.3 QUALIFICATIONS

A. Installer Qualifications: Installer shall meet one of the following qualifications, documentation shall be provided to demonstrate compliance.

1. A firm that has been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."
2. A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Installer shall provide documented evidence of training or qualifications for installing firestopping systems and products.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Do not apply materials when temperature of substrate material and ambient air is below 60 degrees F or manufacturer’s recommendations.

B. Maintain this minimum temperature before, during, and minimum 3 days after installation of materials.

1.5 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

PART 2 - PRODUCTS

2.1 PENETRATION FIRESTOPPING

A. Manufacturers: Subject to compliance with requirements:

1. Hilti, Inc.
2. Specified Technologies Inc.
3. 3M Fire Protection Products.
4. Other manufacturers listed in the UL Fire Resistance Directory – Volume 2.

B. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

C. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. Fire-resistance-rated walls include fire-barrier walls and fire partitions.
2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.

D. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. Horizontal assemblies include floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
4. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.

E. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

2.2 ACCESSORIES

A. Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:

    a. Slag-wool-fiber or rock-wool-fiber insulation.
    b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    c. Fire-rated form board.
    d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.3 FILL MATERIAL

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and non-sag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of non-sag grade for both opening conditions.

PART 3 - EXECUTION

3.1 GENERAL

A. Install penetration firestopping systems at locations as noted on drawings or as indicated as a requirement on approved core permit. Firestopping system F-Rating shall meet or exceed the wall or floor rating as noted on drawings.

3.2 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.3 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove foreign materials from surfaces of opening substrates and from penetrating items that could interfere with adhesion of penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer, and use that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Mask all firestop systems with tape to provide precise and professional finished product and to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to

remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

D. Mixing

1. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

3.4 INSTALLATION

A. General: Install firestopping system components to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.5 IDENTIFICATION

A. Identify penetration firestopping with preprinted labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that the firestopping system is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated firestopping and install new materials to produce systems complying with specified requirements.

3.7 FIELD QUALITY CONTROL

A. Engage a qualified inspection agency to conduct and report on inspections in accordance with ASTM E2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION 078400

SECTION 090101 – EXTERIOR ATMOSPHERIC COATINGS - STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Approved Coatings
2. Surface Preparation
3. Coatings Application
4. Coatings Repair

B. The work under this section shall consist of surface preparation and coating of steel subject to exterior atmospheric service as specified on the project plans or within the project documents.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit technical data sheet (TDS) and safety data sheets (SDS) for each coating and lining material, solvent, cleaning agent, abrasive blast media, and all other potentially hazardous material to be used shall be submitted.
2. Substitution requests shall be submitted in ample time to allow the testing and qualification requirements indicated below.

B. Contractor Submittals:

1. List of all proposed equipment and application methods.
2. Samples of the abrasive blast media to be evaluated for size and cleanliness.

C. Manufacturer Submittals:

1. Manufacturer's surface preparation recommendations and application instructions, drying time, time to recoat, and defect repair.

D. Informational Submittals:

1. Applicator's daily records:

a. Submit daily QC records at end of each workday in which coating or surface preparation work is performed unless requested otherwise by the CAWCD's on-site representative.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. The Contractor shall only employ trained, competent, and experienced applicators who have successfully applied the specified coating system(s).
2. Contractor employees assigned to make dry film thickness (DFT) measurements shall possess the experience and qualifications to accurately undertake these measurements and tests.

B. Contractor Field Sampling and Testing:

1. CAWCD may require the Contractor to take samples of both paint components at random from the products delivered to the jobsite for testing to verify that the products conform to this specification. Products not in conformance shall be removed from the jobsite and replaced with products that conform to this specification.
2. Impresser tape system for surface profile testing to be performed per NACE RP02873 and surface profile test results shall be submitted with daily QC reports.

C. Container Marking and Shipping Certifications:

1. Color pigments shall be ground in at the factory and be of the highest quality. Each container shall be clearly marked with the manufacturer’s batch number, Federal Standard Color Number (FS 595a), and color. Certification that the furnished coating materials comply with these requirements shall accompany each shipment.

D. Coatings manufacturer’s batch numbers shall be recorded on the daily QC sheet.

E. Inspection and Tests:

1. The Contractor shall ensure all necessary testing and inspection instruments are properly calibrated and maintained for the Contractor's own use when conducting inspection of the work to ensure compliance with the project specifications. Contractor shall provide all calibration documentation for each piece of inspection testing equipment. Contractor shall make available inspection testing equipment to CAWCD personnel.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver in original sealed containers, legibly labeled at the time of use with the following information:

1. Name or type number of material
2. Manufacturer's name and item stock number
3. Date of manufacture and batch number
4. Contents, by volume, of major constituents
5. Warning labels
6. VOC content

B. Materials shall be stored and mixed only in areas designated for that purpose and approved by CAWCD.

C. All materials shall be stored in accordance with manufacturer’s instructions, in a well-ventilated area, with precautionary measures taken to prevent fire hazards.

D. Storage and mixing areas shall be kept clean and free of rags, waste, and scrapings. Containers shall be kept tightly closed after each mixing or use.

E. NO SMOKING signs shall be hung over the door and inside each paint storage or mixing room.

F. Requirements of Regulatory Agencies: The products, equipment, and work specified in this section are subject to the rules and regulations of the Arizona Department of Environmental Quality (ADEQ). Surface preparation and application of coatings shall be performed by the Contractor in compliance with all applicable federal, state, and local occupational safety and health regulations. Obtain and comply with all safety precautions recommended by the paint manufacturer in printed instructions or special bulletins and as required by applicable regulations. Provide forced ventilation in all areas where inadequate ventilation exists. Perform Work in accordance with State of Arizona or Municipality standards when working outside of CAWCD right-of-way, in CAWCD easements.

1.5 SAFETY METHODS

A. Safety methods in surface preparation and coating application shall be established in accordance with OSHA CFR 1926, Subpart C – General Safety and Health Provisions, E – Personal Protective and Life Saving Equipment, M – Fall Protection, and Subpart AA – Confined Spaces in Construction.

B. When mineral spirits or other chemicals are used, impermeable gloves, goggles or face shields, and other recommended protective equipment shall be used to avoid skin, eye, and respiratory contamination.

C. Established safety methods shall be implemented in accordance with the guidelines and safety requirements of the product SDS.

D. The contractor shall provide rigging and safety harness equipment for access to roofs or steep slopes in accordance with OSHA requirements and the Bureau of Reclamation's Safety and Health Standards.

PART 2 - PRODUCTS

2.1 EXTERIOR COATINGS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Atmospheric Outdoor Service Coatings:

a. Induron Indurlux 7600
b. PPG Amerlock 2 / Sigmacover 2 for prime and intermediate coats
c. PPG PSX 700(sg)
d. PPG Amershield Color / Top Coats
e. Approved Direct to Metal (DTM) coatings system

f. Dunn Edwards Aristoshield for topcoat / PPG Amercoat 235 for prime and intermediate coats

B. General:

1. Materials shall be used within the pot life recommended by the manufacturer.
2. Manufacturer's Standards: Comply with manufacturer's recommendations and standards unless otherwise specified. If specific details are in question, CAWCD shall be consulted. CAWCD must approve proposed changes or deviations prior to proceeding with the proposed change or deviation.
3. Furnish coating system through one (1) manufacturer unless noted otherwise.
4. Unless otherwise noted, coating colors to be the following as identified in contract documents:

a. Mesa Tan
b. Check Grey
c. CAP Safety Yellow
d. CAP Safety Red

2.2 ABRASIVE BLAST MATERIAL

A. Use of abrasive blast media shall be in compliance with federal, state and local regulations, including Arizona Administrative Code R18-2-702.B-C and R18-2-730.A, B, D, F and G.

PART 3 - EXECUTION

3.1 PREPARATION

A. General Preparation:

1. Follow all paint manufacturer's mixing instructions and must meet paint recoat windows.
2. Prepare surfaces to be painted in accordance with coating manufacturer's instructions and this Specification Section. Where discrepancy between coating manufacturer's instructions and this Specification Section exists, the more stringent preparation shall be provided unless approved otherwise, in writing, by CAWCD.
3. All grease, oil, wax, tar, and other similar residues shall be removed according to SSPC-SP1. After cleaning and before blasting, the surfaces requiring coating application shall be verified to have acceptable levels of soluble salt contamination in accordance with manufacturer's requirements.
4. Following abrasive blasting all surfaces that have been prepared to receive coatings shall be dry and free of all contaminants to assure a clean surface at the time of coating application; additionally:

a. If the blast is lost, the area where the blast was lost shall be re-blasted to manufacturer specification or SP-10 NACE 2 in the absence of manufacturer surface prep specification

B. Carbon Steel Surfaces:

1. Carbon steel surfaces to be coated shall be abrasive blasted in accordance with manufacturer specification or SSPC SP-10 / NACE 2, near-white metal blast (in the absence of manufacturer prep specification).
2. All sharp edges, slivers, weld slag, weld spatter, and metal laminations shall be removed by grinding.
3. For small repairs, prepare the surface according to SSPC-SP11 Power-Tool Cleaning to Bare Metal, using a bristle blaster to provide a minimum surface profile of 1.5 mils.
4. Steel defects requiring repair may be apparent after surface preparation. Advise CAWCD of all areas exhibiting defects such as excessive metal loss cracking or pitting.
5. All surface preparation for repairs shall be performed in accordance to applicable manufacturer recommendations and, or as approved in accordance with the SSPC standards SP1-SP3, SP5, SP7, SP10, and SP11.

3.2 PROTECTION

A. General:

1. The Contractor shall protect all parts of the structure against disfigurement by spatters, splashes, and smirches of paint or paint materials. The Contractor shall be responsible for any damage caused by the Contractor's operations to vehicles, persons, or property, and shall provide protective means to guard against such damage at his expense. Paint stains which might result in an unsightly appearance shall be removed or obliterated by the Contractor. When ordered by CAWCD, or if traffic causes an objectionable amount of dust, the Contractor shall wet the adjacent roadbed and shoulders with water for a distance on each side of the location where painting is being done sufficient to abate the dust nuisance. The Contractor shall furnish and post at his own expense DRIVE SLOWLY signs and take other necessary precautions to prevent dust and dirt from accumulating on freshly painting surfaces.

3.3 APPLICATION

A. General:

1. At minimum, the spray application shall be in accordance with SSPC PA-1 and provide a finish that is continuous, uniform in thickness, and free of pores, discontinuities, or holidays will be allowed.
2. All surfaces receiving the coating shall be visually dry and at least 5^{o}F above the dew point prior to starting the application to prevent moisture entrapment. Unless directed otherwise by manufacturer specifications.
3. Paints specified are formulated ready for application and no thinning will be allowed. If the paint becomes thick in cool weather, it shall be heated in the container or immersed in hot water. Paint to be thinned per manufacturer's instructions if thinning is needed.
4. Coatings shall be applied, and defects repaired as needed per SSPC PA-1

5. Before closing the work at the end of the day, all layers of material shall be applied to minimize coating contamination, except at the “returning edge”. Extreme care shall be taken to prevent contamination of the membrane surface that could affect adhesion between coats. If the coating is not completed by the end of the workday, then at the end of the workday a 3 to 12 inch “returning edge” of material will be left tapered to the substrate for the start of the next workday. The “returning edge” shall be profiled, or if necessary, solvent cleaned with a high flashpoint solvent as recommended by the manufacturer of the lining before proceeding to spray on the lining for the start-up the following workday.

B. Carbon Steel Surfaces:

1. Coating systems to be applied per manufacturer specification, unless directed otherwise by CAWCD.
2. The coating shall be applied as a liquid seamless system by spray direct-to-steel surfaces, allowing the material to conform to the profile of the substrate, creating a seamless monolithic film. The minimum DFT shall be per manufacturer recommendation.
3. Unless otherwise required on the contract documents, prime and finish coats for steel surfaces shall applied per manufacturer recommendations. The total dry film thickness shall be not less than 3 mills.
4. Stripe coat sharp edges, rivets, welds, or any irregularities with the potential to cause inadequate coverage.
5. DFT shall be measured after materials have set up dry to the touch, in accordance with SSPC PA2 - Type 2

3.4 CLEANING

A. During the progress of the work, discarded materials, rubbish, cans, and rags shall be properly disposed of at the end of each work shift.

B. Upon completion of the coating work, masking tape, tarps, and any other protective materials shall be removed from the project area using care not to scratch or otherwise damage the finished surfaces

END OF SECTION 090101

SECTION 090102 – INTERIOR ATMOSPHERIC COATINGS - STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Approved Coatings
2. Surface Preparation
3. Coatings Application
4. Coatings Repair

B. The work under this section shall consist of surface preparation and coating of steel subject to exterior atmospheric service as specified on the project plans or within the project documents.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit technical data sheet (TDS) and safety data sheets (SDS) for each coating and lining material, solvent, cleaning agent, abrasive blast media, and all other potentially hazardous material to be used shall be submitted.
2. Substitution requests shall be submitted in ample time to allow the testing and qualification requirements indicated below.

B. Contractor Submittals:

1. List of all proposed equipment and application methods.
2. Samples of the abrasive blast media to be evaluated for size and cleanliness.

C. Manufacturer Submittals:

1. Manufacturer's surface preparation recommendations and application instructions, drying time, time to recoat, and defect repair.

D. Informational Submittals:

1. Applicator's daily records:

a. Submit daily QC records at end of each workday in which coating, or surface preparation work is performed unless requested otherwise by the CAWCD's on-site representative.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. The Contractor shall only employ trained, competent, and experienced applicators who have successfully applied the specified coating system(s).
2. Contractor employees assigned to make dry film thickness (DFT) measurements shall possess the experience and qualifications to accurately undertake these measurements and tests.

B. Contractor Field Sampling and Testing:

1. CAWCD may require the Contractor to take pint samples of both paint components at random from the products delivered to the jobsite for testing to verify that the products conform to this specification. Products not in conformance shall be removed from the jobsite and replaced with products that conform to this specification.
2. Impresser tape system for surface profile testing to be performed per NACE RP02873 and surface profile test results shall be submitted with daily QC reports.

C. Container Marking and Shipping Certifications:

1. Color pigments shall be ground in at the factory and be of the highest quality. Each container shall be clearly marked with the manufacturer’s batch number, Federal Standard Color Number (FS 595a), and color. Certification that the furnished coating materials comply with these requirements shall accompany each shipment.

D. Coatings manufacturer’s batch numbers shall be recorded on the daily QC sheet.

E. Inspection and Tests:

1. The Contractor shall ensure all necessary testing and inspection instruments are properly calibrated and maintained for the Contractor's own use when conducting inspection of the work to ensure compliance with the project specifications. Contractor shall provide all calibration documentation for each piece of inspection testing equipment. Contractor shall make available inspection testing equipment to CAWCD personnel.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver in original sealed containers, legibly labeled at the time of use with the following information:

1. Name or type number of material
2. Manufacturer's name and item stock number
3. Date of manufacture and batch number
4. Contents, by volume, of major constituents
5. Warning labels
6. VOC content

B. Materials shall be stored and mixed only in areas designated for that purpose and approved by CAWCD.

C. All materials shall be stored in accordance with manufacturer’s instructions, in a well-ventilated area, with precautionary measures taken to prevent fire hazards.

D. Storage and mixing areas shall be kept clean and free of rags, waste, and scrapings. Containers shall be kept tightly closed after each mixing or use.

E. NO SMOKING signs shall be hung over the door and inside each paint storage or mixing room.

F. Requirements of Regulatory Agencies: The products, equipment, and work specified in this section are subject to the rules and regulations of the Arizona Department of Environmental Quality (ADEQ). Surface preparation and application of coatings shall be performed by the Contractor in compliance with all applicable federal, state and local occupational safety and health regulations. Obtain and comply with all safety precautions recommended by the paint manufacturer in printed instructions or special bulletins and as required by applicable regulations. Provide forced ventilation in all areas where inadequate ventilation exists. Perform Work in accordance with State of Arizona or Municipality standards when working outside of CAWCD right-of-way, in CAWCD easements.

1.5 SAFETY METHODS

A. Safety methods in surface preparation and coating application shall be established in accordance with OSHA CFR 1926, Subpart C – General Safety and Health Provisions, E – Personal Protective and Life Saving Equipment, M – Fall Protection, and Subpart AA – Confined Spaces in Construction.

B. When mineral spirits or other chemicals are used, impermeable gloves, goggles or face shields, and other recommended protective equipment shall be used to avoid skin, eye, and respiratory contamination.

C. Established safety methods shall be implemented in accordance with the guidelines and safety requirements of the product SDS.

D. The contractor shall provide rigging and safety harness equipment for the access to roofs or steep slopes in accordance with OSHA requirements and the Bureau of Reclamation's Safety and Health Standards.

PART 2 - PRODUCTS

2.1 INTERIOR COATINGS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Atmospheric Indoor Service Coatings:

a. Induron Indurlux 7600
b. PPG Amerlock 2 / Sigmacover 2 for prime and intermediate coats
c. PPG PSX 700(sg)
d. PPG Amershield Color / Top Coats
e. Approved Direct to Metal (DTM) coatings system

f. Dunn Edwards Aristoshield for top coat / PPG Amercoat 235 for prime and intermediate coats

B. General:

1. Materials shall be used within the pot life recommended by the manufacturer.
2. Manufacturer's Standards: Comply with manufacturer's recommendations and standards unless otherwise specified. If specific details are in question, CAWCD shall be consulted. CAWCD must approve proposed changes or deviations prior to proceeding with the proposed change or deviation.
3. Furnish coating system through one (1) manufacturer unless noted otherwise.
4. Unless otherwise noted, coating colors to be the following as identified in contract documents:

a. Mesa Tan
b. Check Grey
c. CAP Safety Yellow
d. CAP Beige
e. Grey Bolts
f. Tucson Brown

2.2 Abrasive Blast Material

A. Use of abrasive blast media shall be in compliance with federal, state and local regulations, including Arizona Administrative Code R18-2-702.B-C and R18-2-730.A, B, D, F and G.

PART 3 - EXECUTION

3.1 PREPARATION

A. General Preparation:

1. Follow all paint manufacturer's mixing instructions and must meet paint recoat windows.
2. Prepare surfaces to be painted in accordance with coating manufacturer's instructions and this Specification Section. Where discrepancy between coating manufacturer's instructions and this Specification Section exists, the more stringent preparation shall be provided unless approved otherwise, in writing, by CAWCD.
3. All grease, oil, wax, tar, and other similar residues shall be removed according to SSPC-SP1. After cleaning and before blasting, the surfaces requiring coating application shall be verified to have acceptable levels of soluble salt contamination in accordance with manufacturer's requirements.
4. Following abrasive blasting all surfaces that have been prepared to receive coatings shall be dry and free of all contaminants to assure a clean surface at the time of coating application; additionally:

a. If the blast is lost, the area where the blast was lost shall be re-blasted to manufacturer specification or SP-10 NACE 2 in the absence of manufacturer surface prep specification

B. Carbon Steel Surfaces:

1. Carbon steel surfaces to be coated shall be abrasive blasted in accordance with manufacturer specification or SSPC SP-10 / NACE 2, near-white metal blast (in the absence of manufacturer prep specification).
2. All sharp edges, slivers, weld slag, weld spatter, and metal laminations shall be removed by grinding
3. For small repairs, prepare the surface according to SSPC-SP11 Power-Tool Cleaning to Bare Metal, using a bristle blaster to provide a minimum surface profile of 1.5 mils.
4. Steel defects requiring repair may be apparent after surface preparation. Advise CAWCD of all areas exhibiting defects such as excessive metal loss cracking or pitting.
5. All surface preparation for repairs shall be performed in accordance to applicable manufacturer recommendations and, or as approved in accordance with the SSPC standards SP1-SP3, SP5, SP7, SP10, and SP11.

3.2 PROTECTION

A. General:

1. The Contractor shall protect all parts of the structure against disfigurement by spatters, splashes, and smirches of paint or paint materials. The Contractor shall be responsible for any damage caused by the Contractor's operations to vehicles, persons, or property, and shall provide protective means to guard against such damage at his expense. Paint stains which might result in an unsightly appearance shall be removed or obliterated by the Contractor. When ordered by the Engineer, or if traffic causes an objectionable amount of dust, the Contractor shall wet the adjacent roadbed and shoulders with water for a distance on each side of the location where painting is being done sufficient to abate the dust nuisance. The Contractor shall furnish and post at his own expense DRIVE SLOWLY signs and take other necessary precautions to prevent dust and dirt from accumulating on freshly painting surfaces.

3.3 APPLICATION

A. General:

1. At minimum, the spray application shall be in accordance with SSPC PA-1 and provide a finish that is continuous, uniform in thickness, and free of pores, discontinuities, or holidays will be allowed.
2. All surfaces receiving the coating shall be visually dry and at least 5ºF above the dew point prior to starting the application to prevent moisture entrapment. Unless directed otherwise by manufacturer specifications.
3. Paints specified are formulated ready for application and no thinning will be allowed. If the paint becomes thick in cool weather, it shall be heated in the container or

immersed in hot water. Paint to be thinned per manufacturer's instructions if thinning is needed.

4. Coatings shall be applied, and defects repaired as needed per SSPC PA-1
5. Before closing the work at the end of the day, all layers of material shall be applied to minimize coating contamination, except at the "returning edge". Extreme care shall be taken to prevent contamination of the membrane surface that could affect adhesion between coats. If the coating is not completed by the end of the workday, then at the end of the workday a 3 to 12 inch "returning edge" of material will be left tapered to the substrate for the start of the next workday. The "returning edge" shall be profiled, or if necessary, solvent cleaned with a high flashpoint solvent as recommended by the manufacturer of the lining before proceeding to spray on the lining for the start-up the following workday.

B. Carbon Steel Surfaces:

1. Coating systems to be applied per manufacturer specification, unless directed otherwise by the Engineer
2. The coating shall be applied as a liquid seamless system by spray direct-to-steel surfaces, allowing the material to conform to the profile of the substrate, creating a seamless monolithic film. The minimum DFT shall be per manufacturer recommendation
3. Unless otherwise required on the contract documents, prime and finish coats for steel surfaces shall applied per manufacturer recommendations. The total dry film thickness shall be not less than 3 mills.
4. Stripe coat sharp edges, rivets, welds, or any irregularities with the potential to cause inadequate coverage.
5. DFT shall be measured after materials have set up dry to the touch, in accordance with SSPC PA2 - Type 2

3.4 CLEANING

A. During the progress of the work, discarded materials, rubbish, cans, and rags shall be properly disposed of at the end of each work shift.

B. Upon completion of the coating work, masking tape, tarps, and any other protective materials shall be removed from the project area using care not to scratch or otherwise damage the finished surfaces.

END OF SECTION 090102

SECTION 099000 – PAINTING AND COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and field application of paints and other coatings.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit coating materials and performance ratings including VOC content.

B. Shop Drawings (SD):

1. Schedule of products proposed for each system.
2. Samples: Provide 8-inch square drawdowns or brush-outs of topcoat finish. Identify each sample as to finish type, formula, color name and number, sheen name, and gloss units.

C. General (G):

1. Submit manufacturer's Installation Instructions, including but not limited to:

a. Surface preparation.
b. Method of application.
c. Compatible and non-compatible prime coats.

D. Operation and Maintenance Data:

1. Submit maintenance and cleaning instructions.

1.3 QUALITY ASSURANCE

A. Materials for Each Paint System: By single manufacturer.

B. Regulatory Requirements: Comply with by using paints that do not exceed governing agency's VOC limits or do not contain lead.

C. Surface preparation shall conform to the current Steel Structures Painting Council (SSPC) Specifications.

D. Field Samples: Paint one complete surface of each color scheme to show colors, finish texture, materials and workmanship. Obtain approval before painting other surfaces.

E. Compatibility of Coatings: Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.

1.4 QUALIFICATIONS

A. Installer:

1. Company experienced in application of specified coatings with minimum five years documented experience.
2. Manufacturer approved applicator when manufacturer has approved applicator program.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver paint materials in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, batch number, date of manufacturer, expiration date or shelf life, color designation and instructions for mixing and/or reducing.

B. Remove unspecified and unapproved paints from Project site immediately.

C. Provide adequate storage facilities. Store paint materials at minimum ambient temperature between 45ºF (7ºC) and 90ºF (32ºC) in well-ventilated area, unless otherwise recommended by the manufacturer.

D. Keep containers sealed until ready for use.

E. Do not use materials beyond manufacturer’s shelf-life limits.

F. Handling: Protect materials during handling and application to prevent damage or contamination.

G. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.6 FIELD CONDITIONS

A. Do not install materials under dusty conditions.

B. Do not install materials when relative humidity is higher than 85 percent.

C. Do not install materials when surface temperature is less than 5 degrees F above dew point.

D. Do not install materials when temperature is below 55 degrees F or above 90 degrees F unless manufacturer allows a higher temperature.

E. Maintain this temperature range, 24 hours before, during, and 48 hours after installation of coating.

F. Provide lighting level of 80 ft-candles measured mid-height at substrate surface.

G. Restrict traffic from area where coating is being applied or is curing.

1.7 HEALTH AND SAFETY REQUIREMENTS

A. Work shall comply with applicable federal, state, and local laws and regulations including analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1.8 EXTRA MATERIALS

A. Supply 1 gallon of each color of each type of coating used on the project.

B. Label each container with manufacturer's name, product number, color number, and location where used.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers:

1. Ameron: Ameron International, Brea, CA.
2. Carboline: Carboline, St. Louis, MO.
3. International/Devoe: International Protective Coatings, Houston, TX.
4. S-W: Sherwin-Williams Co., Cleveland, OH.
5. Tnemec: Tnemec Co., Kansas City, MO.
6. Dunn-Edwards: Dunn-Edwards Corporations, Los Angeles, CA.
7. PPG: Pittsburg, PA.

2.2 GENERAL

A. Coatings: Ready mixed except field catalyzed coatings of good flow and brushing properties, capable of drying or curing free of streaks or sags.

1. Chromium content, as zinc chromate or strontium chromate: None.
2. Maximum VOC content: As required by applicable regulations.
3. Colors: Refer to Coating Schedule below.

B. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve finishes specified; commercial quality.

2.3 PRETREATMENT, PRIMERS, and PRIMER-SEALERS

A. Low VOC Alkyd Primer:

1. International/Devoe Devprime 1405.
2. Or equivalent product by other vendor as approved by CAWCD.

B. Direct to Metal Primer:

1. International/Devoe Devflex 4020PF.
2. Or equivalent product by other vendor as approved by CAWCD.

C. Concrete, Smooth, Filler/primer:

1. Tnemec W55WB, Tneme-Crete.
2. Or equivalent product by other vendor as approved by CAWCD.

D. Concrete Masonry Filler:

1. Dunn-Edwards: Smooth BLOCFIL Premium.
2. Sherwin Williams: B42W25, Block Filler Interior/Exterior.
3. Tnemec: 130-6601, Envirofil.
4. Or equivalent product by other vendor as approved by CAWCD.

2.4 PAINTS, EXTERIOR EXPOSURE

A. Water-borne Acrylic – Flat:

1. International/Devoe Devflex 4020 PF.
2. Or equivalent product by other vendor as approved by CAWCD.

B. Water-borne Acrylic – Gloss:

1. International/Devoe Devcryl 1449.
2. Sherwin Williams: B66-600 Pro Industrial Acrylic Gloss.
3. Or equivalent product by other vendor as approved by CAWCD.

C. Latex - Flat:

1. Dunn-Edwards Spartashield Exterior Flat.
2. Sherwin Williams A100, Exterior Latex Flat.
3. Tnemec W55WB, Tneme-Crete.
4. Or equivalent product by other vendor as approved by CAWCD.

2.5 PAINT, INTERIOR EXPOSURE

A. Acrylic Enamel – Eggshell:

1. Sherwin Williams: B66-660 Pro Industrial Acrylic Eggshell.
2. Or equivalent product by other vendor as approved by CAWCD.

B. Acrylic Enamel – Semi-Gloss:

1. Sherwin Williams: B66-650 Pro Industrial Acrylic Semi-Gloss.
2. Or equivalent product by other vendor as approved by CAWCD.

C. Acrylic Enamel – Gloss:

1. Sherwin Williams: B66-600 Pro Industrial Acrylic Gloss.
2. Or equivalent product by other vendor as approved by CAWCD.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify substrate surfaces are ready to receive Work as instructed by coating manufacturer. Obtain and follow manufacturer's instructions for examination and testing of substrates.

B. Cementitious Substrates: Do not begin application until substrate has cured 28 days minimum.

3.2 PROTECTION

A. Adequately protect other surfaces from paint and damage. Repair damage as a result of inadequate or unsuitable protection.

B. Furnish sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.

C. Place cotton waste, cloths, and material that may constitute a fire hazard in closed metal containers and remove daily from site.

3.3 PREPARATION

A. Clean surfaces of loose foreign matter.

B. Prepare surfaces in accordance with coating manufacturer's instructions, unless more stringent requirements are specified in this Specification.

C. Correct minor defects and clean surfaces affecting work of this section.

D. Remove electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or applying finishes.

E. Concrete Masonry: Remove dirt, loose mortar, scale, powder and other foreign matter. Remove oil and grease with solution of tri-sodium phosphate. Remove stains caused by weathering of corroding metals with solution of sodium metasilicate. Rinse well and allow to thoroughly dry. Spot prime exposed metal with alkyd primer.

F. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent.

G. Ferrous Metal:

1. Solvent clean.
2. Remove loose rust, loose mill scale, and other foreign substances by blasting according to SSPC-SP 6.
3. For surfaces to be finished with Alkyd, remove tight rust to bare metal by blasting according to SSPC-SP 6 (Commercial Blast Cleaning), and protect from corrosion until coated.

H. Shop Primed Metal:

1. Certify that primers applied to metal surfaces in the shop are compatible with coatings to be applied over such primers in the field.
2. Correct abraded, scratched or otherwise damaged areas of shop prime coat by sanding or abrasive blasting in accordance with SSPC SP-6.
3. When entire shop priming fails or has weathered excessively, or when recommended by coating manufacturer, abrasive blast shop prime coat to remove entire coat and prepare surface in accordance with SSPC SP-6.
4. When incorrect prime coat is applied, remove incorrect prime coat by abrasive blasting in accordance with SSPC SP-6.

I. Grind sharp edges to approximately 1/16-inch radius.

J. Remove and grind smooth all excessive weld material and weld spatter before blast cleaning.

3.4 APPLICATION REQUIREMENTS

A. Concrete Masonry: Apply masonry filler to manufacturers recommended thickness.

B. Sand surfaces lightly between coats to achieve required finish.

C. Apply coatings to thickness as specified by manufacturer.

D. The number of coats scheduled is the minimum number of coats required. Additional coat(s) shall be applied if required to achieve a specified minimum thickness, or to completely hide base material.

E. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

F. Dust coatings between coats. Lightly sand and dust surfaces to receive high gloss finishes, unless instructed otherwise by coating manufacturer.

G. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.

H. Drying and Recoating:

1. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.
2. Limit drying time to that required by these Specifications or coating manufacturer's instructions.
3. Do not allow excessive drying time or exposure which may impair bond between coats.
4. When time limits are exceeded, abrasive blast clean prior to applying another coat. Or follow manufacturer’s recommendations, whichever is more stringent.

I. Apply coating by brush, roller, trowel, or spray, unless particular method of application is required by coating manufacturer's instructions or these Specifications.

J. Spray Application:

1. Stripe coat edges of all plates, weld joints, nuts, and bolts by brush before beginning spray application, as necessary, to ensure specified coating thickness along edges.
2. When using spray application, apply coating to thickness not greater than that suggested in coating manufacturer's instructions for brush coat application.
3. Use airless spray method, unless air spray method is required by coating manufacturer's instruction or these Specifications.
4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist or spray.

K. Finishing Mechanical and Electrical Equipment:

1. Refer to Section construction drawings for schedule of color coding, identification banding of equipment, duct work piping, and conduit.
2. Color code items in accordance with color schedule. Color band and identify with flow arrows, names, and numbering.
3. Paint shop primed equipment.
4. Remove unfinished louvers, grilles, covers, and access panels and paint separately. Paint dampers exposed behind louvers, grilles, convector and baseboard cabinets to match face panels.
5. Prime and paint insulated and exposed pipes, insulated and exposed ducts, hangers, brackets, collars and supports, except where items are prefinished.
6. Paint interior surfaces of air ducts visible through grilles and louvers with one coat of flat black paint to visible surfaces.
7. Paint exposed conduit and electrical equipment occurring in finished areas.
8. Paint both sides and edges of plywood backboards.
9. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.5 FIELD QUALITY CONTROL

A. Each coat of material applied shall be inspected and approved by CAWCD before application of the succeeding specified coat. Contractor shall notify CAWCD when each coat is completed.

B. Coating mil thickness shall be verified by the following methods:

1. Over ferrous metal: Elcometer Film Gauge.
2. Other surfaces: Tooke Dry Mil Inspection Gauge.

3.6 ADJUSTING

A. At completion, perform touch-up and re-coat work and leave finish surfaces in good condition.

B. Coating mil thickness shall be verified by the following methods:

1. Over ferrous metal: Elcometer Film Gauge or equivalent approved by CAWCD.

2. Other surfaces: Tooke Dry Mil Inspection Gauge or equivalent approved by CAWCD.

3.7 CLEANING

A. As work proceeds and upon completion, promptly remove paint where spilled, splashed, or spattered.

B. Upon completion of work, leave premises neat and clean.

3.8 SCHEDULE – EXTERIOR SURFACES

A. Concrete Substates:

1. Primer: Concrete Masonry Filler.
2. 2nd and 3rd Coats: Exterior Flat Latex.

B. Exterior Steel:

1. Prime Coat: Direct to Metal Primer.
2. Intermediate/Finish Coat: Acrylic - Flat.

C. Exterior Metal:

1. For galvanized items:

a. Clean and prepare surface according to coating manufacturer's recommendations.
b. Prime Coat: Direct to Metal Primer.
c. Intermediate/Finish Coat: Acrylic – Flat.
d. Galvanized touch-up painting shall be in accordance with the latest version of the Maricopa Association of Governments (MAG) Uniform Standard Specifications and Details for Public Works Construction.

END OF SECTION 099000

SECTION 099610 - SURFACE PREPARATION AND COATING INSPECTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements of inspection procedures to ensure:

1. All materials required to be coated will meet the required surface conditions per the contract specifications using SSPC standards or customer requirements.
2. Finished products are in accordance with the project specifications.
3. Section 099610 to be used in combination with Section 099000.

1.2 QUALITY ASSURANCE AND QUALITY CONTROL

A. The Contractor shall employ a Contractor Quality Control Coordinator (QCC) who shall be responsible for continuing quality assurance and control of the work in accordance with all procedures and inspection requirements contained in the Specifications and governing documents. The qualifications of the proposed QCC shall be submitted to CAWCD for acceptance.

B. CAWCD may hire an independent 3rd party NACE Certified Level III coating inspector who shall verify that all the work is being performed in accordance with the Specifications and document all non-conforming work. This work will be to audit the quality control work by the QCC.

1.3 DEFINITIONS

A. DFT—Dry Film Thickness

B. DPIR—Daily Paint Inspection Report

C. Durometer—An inspection tool used to determine the hardness and level of cure in an applied coating film.

D. Inspector – CAWCD designated individuals performing inspections

E. NACE—NACE International, formerly National Association of Corrosion Engineers

F. NCR—Non-Conformance Report

G. NDTE—Non-Destructive Test Equipment

H. Quality Assurance—The planned and systemic activities implemented in a quality system so that quality requirements for a product or service will be fulfilled

I. Quality Control—The observation techniques and activities used to fulfill requirements for quality

J. QCI – Quality Control Individual

K. SSPC—Society for Protective Coatings

PART 2 - PRODUCTS

2.1 TESTING EQUIPMENT

A. The Contractor shall ensure all necessary testing and inspection instruments are properly calibrated and maintained and are available for the Contractor's own use in conducting surveillance of the work to ensure compliance with the project specifications.

B. Instrumentation—the Contractor shall use the following inspection equipment to perform quality control testing:

1. Adequate lighting to properly inspect the Work, at all stages
2. Dew point check or other approved thermometer/hygrometer
3. Surface temperature thermometer
4. Ambient temperature thermometer
5. High range wet and dry film thickness gages
6. Micrometer
7. Durometer
8. Sample cans
9. Inspection glass (30x power minimum)
10. High voltage holiday detector (Tinker and Rasor Model AP-W, or equivalent)

C. The Contractor's NACE CIP certified inspector shall ensure they have their own independent necessary testing and inspection instruments and that those are properly calibrated and maintained.

PART 3 - EXECUTION

3.1 INSPECTION AND TESTS

A. At a minimum, inspections shall occur at the following points:

1. Immediately before surface preparation
2. Immediately following surface preparation
3. Following application and drying of each coat
4. After lining repairs are completed
5. Final walk-down
6. Final acceptance

B. Tests shall be performed in the presence of CAWCD personnel. Tests performed in the absence of CAWCD personnel may not be accepted and shall be retested in CAWCD’s presence.

C. Adequate lighting, conforming to SSPC-Guide 12 at a minimum, shall be provided for all inspections.

D. Maintain Daily Records, Tests and Reports:

1. Record the following information including, but not limited to:

    a. Date, starting time, end time, and all breaks taken by painters
    b. Compressed air quality per ASTM D4285
    c. Report of environmental conditions prior to coating application, including substrate temperature, ambient temperature, relative humidity, and dew point
    d. Report on observation of surface preparation, including anchor profile, prior to lining application
    e. Wet and dry film thickness measurements

2. The temperature, dew point, and relative humidity shall be determined in accordance with ASTM E337. Continuous monitoring shall be performed using established and accepted systems, with the measurements at the beginning and end of each shift included in the daily report.

3.2 INSPECTIONS BEFORE SURFACE PREPARATION

A. Prior to using compressed air for surface preparation and application, the quality of the air downstream of the oil and water separator shall be tested. The test shall be conducted as close to the compressor as possible, but downstream of oil and moisture traps, by blowing the air into a clean white blotter, minimum size 9 inches x 11 inches, for two (2) minutes to check for any contamination, oil, or moisture. The ASTM D4285 blotter test shall be performed on the hoses and oil and water separator as well, at the beginning of each shift, at not less than four (4) hour intervals and after any interruption of the air compressor operation, or as required by CAWCD. The air shall be used only if the blotter test indicates no visible contamination, oil, or moisture. If contaminants are evident, the equipment deficiencies shall be corrected and the airstream re-tested. Separators shall be bled continuously. All lines shall be individually tested prior to use.

3.3 INSPECTIONS FOLLOWING SURFACE PREPARATION

A. Surfaces that are determined to have been blasted with contaminated air shall be cleaned and re-blasted with clean air and abrasive. Any coatings/linings that have been determined to have been applied with contaminated air shall be removed and reapplied using clean air.

B. Blast-cleaned surfaces shall be compared with SSPC-VIS 1 or other acceptable standards to determine conformance with the required material surface preparation.

C. The anchor pattern profile depth shall be verified in accordance with ASTM D4417 by using a nondestructive instrument using Testex Press-O-Film replica tape or an acceptable equivalent appropriate to the abrasive material being used.

D. The Inspector shall use an approved grease-free chalk or approved NSF International markers to mark local areas that do not meet the specified standards and require additional surface preparation.

E. The frequency of salt testing shall be determined at the pre-construction meeting with all parties in mutual agreement of the number of tests to be performed based on square footages.

3.4 COATING APPLICATION INSPECTION

A. See Article 3.2.A for compressed air requirements.

B. QCC and QCI shall verify the Contractor completes the following:

1. All areas requiring “no coating” are protected
2. All proper coatings on hand and ready for application
3. The coating materials have not exceeded expiration dates
4. All spray equipment is clean, in good working condition and ready to use
5. Check manufacturer's coating instructions for environmental requirements and application

C. Monitor all environmental readings to determine conditions are acceptable per project specifications and/or coating manufacturer recommendations and all other requirements are met. During material application, the Contractor shall continuously monitor materials, ambient and substrate (surface steel) temperatures, relative humidity, and dew point in the immediate work area and shall be kept within application parameters. Work shall be suspended if conditions are not within recommended limits. The Work shall not proceed if the substrate temperature falls below 5^{o}F above the dew point.

D. Each coat shall be applied in a manner that will produce an even void free film, which resembles the topography of the underlying substrate. Re-coat times, if applicable, shall be in accordance with the Manufacturer's recommendations. Evaluate each coat before proceeding to the next coat. Record start/stop times and station location on daily coating report along with the environmental statistics.

E. Adhesion—ANSI/ASTM D4541 as modified by ANSI/AWWA C210. Adhesion testing is generally only performed when the newly applied coating is suspected of not bonding well to the substrate. This test is destructive and is only performed as directed by CAWCD.

F. During application, wet mil gauges shall be used to verify topcoat film thickness in accordance with ASTM D4414. The DFT shall be measured after materials have set up dry to the touch, in accordance with SSPC-PA-2. The DFT shall be measured by the Inspector with a Type I or Type II gage. The minimum DFT shall be as defined in Section 099000, Article 3.4.B.

G. After the lining material has cured, the coating shall be 100% visually inspected for holes, voids, and thin areas prior to performing holiday detection. The Contractor shall test all coated areas for thin spots and holidays using high-voltage discontinuity testing to assure a “holiday-free” lining system in accordance with NACE Standard SP0274.

H. All detected holidays shall be marked with an approved grease free chalk or NSF International approved marker, repaired, and the repair re-tested according to the coating system Manufacturers' recommendations.

3.5 REPAIRS AND REMEDIAL COATING WORK

A. Defects or damaged areas detected during inspection shall be repaired in accordance with Section 099000, Article 3.6, and the repair retested until they pass the tests and are approved by CAWCD.

B. Remediated areas shall be re-inspected in accordance with Article 3.6.A.

3.6 FINAL INSPECTION

A. After the final application of all coats the surfaces shall be visually checked by the Inspector for evidence of blister, uneven coloring, poor adhesion, or improper cure.

B. Deficiencies in the coating/lining system shall be marked by station number, location, (invert, springline, crown), type (blister, holiday, pinhole), and size, repaired in strict accordance with Article 3.5, and then re-inspected.

C. Records of repair areas by piece mark, location, (invert, springline, crown), type, (blister, holiday, pinhole) and size shall be maintained and submitted to CAWCD as part of the daily inspection report.

3.7 FINAL ACCEPTANCE

A. A final walk-down of completed sections shall be conducted by CAWCD in conjunction with the Contractor for final acceptance. This may occur during the course of construction to minimize foot traffic through the pipe for large diameter pipe or siphons.

END OF SECTION 099610

SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Mechanical sleeve seals
2. Sleeves
3. Escutcheons
4. Grout
5. Fire-suppression equipment and piping demolition and installation
6. Equipment installation requirements common to all sections
7. Concrete bases
8. Supports and anchorages

1.2 ACTION SUBMITTALS

A. Product Data (PD): For all products listed in Part 2, include manufacturers catalog information, performance ratings, rough-in details, weights, support requirements, and piping connections.

B. Shop Drawings (SD):

1. Shop drawings showing specific installation details for concrete bases, anchorage systems or pipe sleeves.

C. Operation and Maintenance Data:

1. Include in final O&M Manuals provided to CAWCD.

D. Quality Control Reports (QCR):

1. Welding qualification certificates.

1.3 QUALITY ASSURANCE

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

1.4 DELIVERY, STORAGE, AND HANDLING

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

1.5 COORDINATION

A. Floor and wall penetrations must be marked, reviewed, and agreed to by CAWCD and approved “Core Drilling Permit” must be obtained prior to any core drill or saw cut of existing CAWCD structures.

B. Coordinate installation of required supporting devices and set sleeves in approved locations.

C. Contractor shall revise existing trapeze hangers where available. Replacement of existing hanger assemblies to accommodate new piping shall be field coordinated.

PART 2 - PRODUCTS

2.1 SLEEVES

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

2.2 ESCUTCHEONS

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

B. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated and rough brass.

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

2.3 CONCRETE BASE

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

B. Refer to structural details and notes in Drawings for concrete pad requirements.

C. 3,000 psi compression strength.

2.4 GROUT

A. Grout shall comply with Specification CAP 509 – Placement of Non-Shrink Cementitious Grout.

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

C. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

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

E. Packaging: Premixed and factory packaged.

2.5 SUPPORTS AND ANCHORAGES

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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

    a. Eaton / Cooper B-Line.
    b. ERICO.
    c. Thomas & Betts.
    d. ITT Grinnell.
    e. Anvil.

2. Metallic Coatings:

    a. Hot-dip galvanized after fabrication and applied according to MFMA-4.
    b. Support systems that directly contact copper pipe and tube shall be coated/designed for use with copper, or the pipe and tube shall be wrapped with 20 mil PVC tape to prevent galvanic corrosion.

3. Channel Dimensions: Selected for applicable load criteria.
4. Channel Dimensions: Selected for applicable load criteria.
5. Stainless steel supports, fittings channels, unistrut, fasteners for outdoor locations.

B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Structural Steel for Fabricated Supports and Restraints: ASTM A 36, steel plates, shapes, and bars.

D. Provide stainless steel as specified for outdoor locations.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following.

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

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

1) Cooper B-Line.
2) Empire Tool and Manufacturing.
3) Hilti.
4) ITW Ramset/Red Head.
5) MKT Fastening.

2. Concrete Inserts: Steel slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

F. Fabricated Metal Equipment Support Assemblies

1. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 FIRE-SUPPRESSION DEMOLITION

A. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed per construction drawings and special provisions.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Piping is not permitted to be abandoned in place. All piping not a part of the new fire protection system will be removed.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and reinstall equipment as shown on construction drawings.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to CAWCD.

B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

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

B. 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.

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

D. Install piping to permit valve servicing.

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

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

1. Split-casting, polished chrome-plates for bare piping at finished spaces
2. Split-casting, rough-brass finish for bare piping at unfinished spaces.

J. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Contractor is required to submit all proposed UL listed fire-resistance rated assemblies for piping/ductwork penetrations to Engineer for review and approval prior to installation. Refer to Section 078400, "Firestopping" for materials.

3.3 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.

1. Refer to structural details and design notes provided in construction drawings for specific requirements.
2. Construct concrete bases of dimensions indicated, but not less than five (5) inches larger in both directions than supported unit.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
4. Install epoxy-coated anchor bolts for supported equipment that extend into concrete base.
5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

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

3.5 GROUTING

A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors in accordance with manufacturer's written instructions.

3.6 FIELD QUALITY CONTROL

A. Sleeves

1. After allowing for a full cure, test sleeves for leaks. Repair leaks and retest until no leaks exist.
2. Sleeves will be considered defective if they do not pass tests and inspections.
3. Prepare test and inspection reports.

3.7 FIRE PROTECTION SYSTEM IDENTIFICATION REQUIREMENTS

A. Valves shall be labeled per CAWCD Specification 220553, or as indicated on project drawings, or as approved by CAWCD.

1. Material: Plastic Laminate

    a. Option 1: Red Background with White Lettering.
    b. Option 2: White Background with Red Lettering.

2. Tag Dimensions: 1-Inch-Wide x 3-Inch-Long.
3. Lettering: 2-Line.

    a. Line 1: Valve ID Number.
    b. Line 2: Normal Operating Position.

4. Hole: (1) Hole at left end of tag, centered.
5. Hanger: 1/16" Stainless Steel cable with ferrule.

B. Fire Alarm Detectors and Alarm Modules:

1. Detectors: All detectors shall be labeled by their detector designator per project drawings.

    a. Text must be a minimum of 3/8" tall with black text on a white background. Use of thermal transfer label printer is acceptable Label shall be outdoor rated.
    b. Example: Detector "N3L1D05". Where: N3 = Fire Alarm Control Panel Node Number, L1 = SLC Loop Number, D05 = Detector Number.

2. Alarm Modules: All alarm modules shall be labeled by their alarm designator per project drawings, modules shall include a short description of their function.

    a. Text must be a minimum of 3/8" tall with black text on a white background. Use of thermal transfer label printer is acceptable. Label shall be outdoor rated.
    b. Example: Alarm Module "N3L1M20", Functional Description "NSFSD1 DAMPER CTRL". Where: N3 = Fire Alarm Control Panel Node Number, L1 = SLC Loop Number, M20 = Module.

C. Control Panels, Power Distribution Panels, Cables, and Conductors shall be labeled per CAWCD Specification 260553.

END OF SECTION 210500

SECTION 210523 - GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Shut-off valves with indicators.
2. Check valves.
3. Bronze OS&Y gate valves.
4. Iron OS&Y gate valves.
5. Indicator posts.
6. Trim and drain valves.

1.2 DEFINITIONS

A. NRS: Non-rising stem.

B. OS&Y: Outside screw and yoke.

C. SBR: Styrene-butadiene rubber.

1.3 ACTION SUBMITTALS

A. Product Data (PD):

1. For each type of valve, include manufacturers catalog information, performance ratings, rough-in details, weights, support requirements, and piping connections.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

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

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

D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig or as required by project drawings.

B. Obtain each type of valve from single manufacturer.

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

1. Fire Main Equipment: HAMV - Main Level.

    a. Indicator Posts, Gate Valve: HCBZ - Level 1.
    b. Ball Valves, System Control: HLUG - Level 3.
    c. Butterfly Valves: HLXS - Level 3.
    d. Check Valves: HMER - Level 3.
    e. Gate Valves: HMRZ - Level 3.

2. Sprinkler System and Water Spray System Devices: VDGT - Main Level.

    a. Valves, Trim and Drain: VQGU - Level 1.

D. ASME Compliance:

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

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

F. NFPA Compliance for Valves:

1. Comply with NFPA 13, NFPA 14, NFPA 20, and NFPA 24.

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

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

I. Valve Actuator Types:

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

2.2 SHUT-OFF VALVES WITH INDICATORS

A. Manufacturers:

1. NIBCO INC.
2. Milwaukee Valve Company.
3. Ames Fire & Waterworks; A Watts Water Technologies Company.

B. Description:

1. UL 1091, for indicating valves (butterfly or ball type), Class Number 1112.
2. Stem: Bronze or stainless steel.
3. Actuator: Worm gear
4. Supervisory Switch: Internal or external.
5. Valves NPS 2 and smaller

    a. Valve Type: Ball, two-piece.
    b. Body Material: Bronze.
    c. Port Size: Full or standard.
    d. Seats: PTFE.
    e. Ball: Chrome-plated brass.
    f. Connection Type: Soldered, threaded, or grooved.

6. Valves NPS 2-1/2 and Larger

    a. Valve Type: Butterfly or OS&Y Gate (as indicated on drawings).
    b. Body Material: Bronze, Cast, or Ductile Iron.
    c. Seat Material: EPDM.
    d. Disc: Bronze, Cast or Ductile Iron with EPDM coating.
    e. Connection Type: Flanged or grooved.

2.3 CHECK VALVES

A. Manufacturers:

1. NIBCO INC.
2. Milwaukee Valve Company.
3. Crane Co.; Crane Valve Group.
4. Ames Fire & Waterworks; A Watts Water Technologies Company.

B. Description:

1. Standard: UL 312 for swing check valves, Class Number 1210.
2. Type: Single swing check.
3. Body Material: Cast iron.
4. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
5. Clapper Seat: Brass, bronze, or stainless steel.
6. Hinge Shaft: Bronze or stainless steel.
7. Hinge Spring: Stainless steel.
8. End Connections: Flanged or grooved.

2.4 IRON OS&Y GATE VALVES

A. Manufacturers:

1. NIBCO INC.
2. Milwaukee Valve Company.
3. Crane Co.; Crane Valve Group.
4. Ames Fire & Waterworks; A Watts Water Technologies Company.

B. Description:

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

2.5 INDICATOR POSTS

A. Manufacturers:

1. NIBCO INC.
2. Kennedy Valve Company.
3. Victaulic Company.

B. Description:

1. Standard: UL 789 for indicator posts.
2. Type: As indicated on Drawings.
3. Base Barrel Material: Cast or ductile iron.
4. Extension Barrel: Cast or ductile iron.
5. Cap: Cast or ductile iron.
6. Operation: Handwheel.

2.6 TRIM AND DRAIN VALVES

A. Manufacturers:

1. NIBCO INC.
2. Milwaukee Valve Company.
3. Ames Fire & Waterworks; A Watts Water Technologies Company.
4. Fire Protection Products Inc (FPPI); A brand of Anvil International.

B. General Requirements:

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

C. Ball Valves:

1. Description:

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

D. Angle Valves:

1. Description:

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

2.7 See Section 211313 for other specialty valves.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 INSTALLATION, GENERAL

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

   1. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in fire-suppression standpipes; wet-pipe, fire-suppression sprinkler systems; and fire-suppression sprinkler systems.
   2. Sections 212200 and 212201 "Clean-Agent Fire-Extinguishing System" for application of valves in AFFF piping.

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

C. Install double-check valve assembly in each fire-protection water-supply connection.

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

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

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

G. Install valve tags. Comply with requirements in Section 220553 "Identification for Service Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

END OF SECTION 210523

SECTION 210529 - HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports for fire-suppression piping - metal.
2. Pipe hangers for fire-suppression piping - metal, trapeze type.
3. Fastener systems.
4. Equipment supports.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit data for each type of product. Submit manufacturers catalog data including load capacity.

B. Shop Drawings (SD):

1. Show fabrication and installation details and include calculations for the following:

a. Trapeze pipe hangers.
b. Equipment supports.

1.3 QUALITY CONTROL REPORTS (QCR):

A. Welders' Certificate: Include welders' certification of compliance with ASME Section IX OR AWS B2.1.

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

1.4 QUALITY ASSURANCE

A. Hangers and supports shall conform to the requirements of the following codes and standards as applicable:

1. ASME B31.1, Power Piping
2. ASME B31.3, Process Piping
3. ASME B31.9, Building Services Piping
4. International Mechanical Code, (IMC)
5. International Plumbing Code, (IPC)
6. NFPA 13, Standard for the Installation of Sprinkler System

1.5 QUALIFICATIONS

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

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.6 FIELD MEASUREMENTS

A. Verify all field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for fire-suppression piping and equipment are to withstand the effects of gravity loads and stresses within limits and under conditions indicated in accordance with ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

C. NFPA Compliance: Comply with NFPA 13.

D. UL Compliance: Comply with UL 203.

2.2 PIPE HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING - METAL

A. Pipe Hangers and Supports for Fire-Suppression Piping - Carbon Steel:

1. Description: Factory-fabricated components, NFPA approved or UL listed for fire-suppression piping support.
2. Galvanized Metallic Coatings: Pre-galvanized or hot-dip galvanized.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

B. Pipe/Tube Hangers and Supports for Fire-Suppression Piping - Copper:

1. Description: Copper-coated-steel, factory-fabricated components, NFPA approved or UL listed for fire-suppression piping support.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.3 PIPE HANGERS FOR FIRE-SUPPRESSION PIPING - METAL, TRAPEZE TYPE

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

2.4 FASTENER SYSTEMS

A. Fastener System - Powder-Actuated Fasteners: Do not use powder-actuated anchors.

B. Fastener System - NFPA/UL Mechanical-Expansion Anchors: NFPA approved or UL listed, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Zinc coated or Stainless.
2. Outdoor Applications: Stainless steel.

2.5 EQUIPMENT SUPPORTS

A. Description: NFPA-approved or UL-listed, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.6 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

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

D. Stainless Steel: ASTM A240/A240M.

E. Refer to CAP Standard Specification 509 - Placement of Non-Shrink Cementitious Grout.

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

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078400 "Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry static loads within specified loading limits. Minimum static design load used for strength determination is to comply with NFPA 13 requirements, minimum 5 times the water-filled weight of piping and supported components plus 250 lb.

C. Do not use powder-actuated anchors.

D. Core drilling or saw cutting existing CAWCD infrastructure requires an CAWCD approved Core Drill Permit before proceeding. See section 210500 for additional information.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

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

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

C. 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. Coordinate location of concrete inserts before concrete is placed.

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

E. Pipe Slopes: Install hangers and supports so that piping maintains required slope.

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

G. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel in accordance with AWS D1.1/D1.1M.

H. Fastener System Installation:

1. Do not use powder actuated anchors.
2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners in accordance with manufacturer's written instructions. Install in accordance with approvals and listings.

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

J. Equipment Support Installation:

1. Fabricate from welded-structural-steel shapes.
2. Grouting: Place grout under supports for floor-mounted equipment and make bearing surface smooth.
3. Provide lateral bracing, to prevent swaying.

3.3 INSTALLATION OF EQUIPMENT SUPPORTS

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

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

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

3.4 METAL FABRICATIONS

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

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

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

3.5 ADJUSTING

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

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

3.6 PAINTING

A. Prime coat exposed steel hangers and supports. Refer to Section 099000.

B. Touchup:

1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
2. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
3. Clean field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal before touchup painting.
4. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

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

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

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

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

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

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

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

H. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

I. 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.

J. Hanger-Rod Attachments: Comply with NFPA requirements.

K. Building Attachments: Comply with NFPA requirements. 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. C-Clamps (MSS Type 23): For structural shapes.
3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

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

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

END OF SECTION 210529

SECTION 210548 - VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Elastomeric hangers.
5. Snubbers.
6. Restraints - rigid type.
7. Restraints - cable type.
8. Restraint accessories.
9. Post-installed concrete anchors.
10. Concrete inserts.

1.2 DEFINITIONS

A. Designated Seismic System: A fire-suppression component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.

B. IBC: International Building Code.

1.3 ACTION SUBMITTALS

A. Product Data (PD):

1. For each type of product, include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Include load rating for each wind-load-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic- and wind-load-restraint component.
4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by ICC-ES product listing, UL product listing or an agency acceptable to authorities having jurisdiction.
5. Annotate to indicate application of each product submitted and compliance with requirements.
6. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings (SD):

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal:

1. For each seismic-restraint and wind-load protection device, including seismic-restrained mounting, pipe-riser resilient support, snubber, seismic restraint, seismic-restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:

    a. Seismic- and Wind-Load- Restraint Selection: Select seismic and wind-load restraints complying with performance requirements, design criteria, and analysis data.
    b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
    c. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
    d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
    e. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" in "Performance Requirements" Article.
    f. Qualified Professional Engineer: All designated-design submittals for seismic and wind-load-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.

2. Seismic- and Wind-Load-Restraint Detail Drawing:

    a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    c. Coordinate seismic restraint details with wind-load restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

3. Product Listing, Preapproval, and Evaluation Documentation: By an evaluation service member of ICC-ES, UL, or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

4. All delegated design submittals for seismic- and wind-load-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.

D. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for fire-suppression piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Welding certificates.

C. Field quality-control reports.

D. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.

1. Provide equipment manufacturer's written certification for each designated active fire-suppression system seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction or experience data as permitted by ASCE/SEI 7.
2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7.
3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.

E. Wind-Load Performance Certification: Provide special certification for fire-suppression system components subject to high-wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-load performance certification.

1. Provide equipment manufacturer's written certification for each designated fire-suppression system device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

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

C. Seismic- and Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: ICC-ES product listing, UL product listing, or an agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design seismic and wind-load control system.

1. Seismic Performance: Equipment must be designed and secured to withstand the effects of earthquake motions determined in accordance with NFPA 13 and ASCE/SEI 7.
2. Wind-Load Performance: Equipment must be designed and secured to withstand the effects of high wind events determined in accordance with ASCE/SEI 7.

B. Seismic Design Calculations:

1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in NFPA 13 and ASCE/SEI 7 or other seismic calculation methods required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the latest edition adopted by the authority having jurisdiction is the edition intended as reference throughout the Section Text.

    a. Data indicated below to be determined by Delegated Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
    b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
    c. Building Occupancy Category: As indicated on Project Drawings.
    d. Building Risk Category: III.
    e. Building Site Classification: E.

2. Calculation Factors, ASCE/SEI 7, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7 unless otherwise noted.

a. Horizontal Seismic Design Force Fp: Value is to be calculated by Delegated Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation:

    1) SDS = Spectral Acceleration: Determined by Delegated Design Contractor based on Project Drawings and ASCE/SEI 7, Section 11.4.5. Value applies to all components on Project.
    2) ap = Component Amplification Factor: See Drawing Schedule for each component.
    3) Ip = Component Importance Factor: See Drawing Schedule for each component.
    4) Wp = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from each component submittal.
    5) Rp = Component Response Modification Factor: See Drawing Schedule for each component.
    6) z = Height in Structure of Point of Attachment of Component for Base: Determine from Project Drawings for each component by Delegated Design Contractor. For items at or below the base, "z" is to be taken as zero.
    7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated Design Contractor.

b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7, Paragraph 13.3.1.2.
c. Seismic Relative Displacement Dpl: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7, Paragraph 13.3.2. Factors below must be obtained for this calculation:

    1) Dp = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculated by Delegated Design Contractor in accordance with ASCE/SEI 7, Paragraph 13.3.2.
    2) Ie = Structure Importance Factor: Determined by Delegated Design Contractor based on Project Drawings and ASCE/SEI 7, Section 11.5.1. Value applies to all components on Project.
    3) δxA = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
    4) δyA = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
    5) δyB = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
    6) hx = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
    7) hy = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
    8) ΔaA = Allowable Story Drift for Structure A: See Drawing Schedules for each component.
    9) ΔaB = Allowable Story Drift for Structure B: See Drawing Schedules for each component.

10) hsx = Story Height Used in the Definition of the Allowable Drift Δa: See Drawings Schedules for each component.

d. Component Fundamental Period Tp: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7, Paragraph 13.3.3. Factors below must be obtained for this calculation:

1) Wp = Component Operating Weight: Determined by contractor from Project Drawings and manufacturer's data.
2) g = Gravitational Acceleration: 32.17 fps2.
3) Kp = Combined Stiffness of Component, Supports, and Attachments: Determined by delegated design seismic engineer.

C. Wind-Load Design Calculations:

1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7 or other wind-load calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the latest edition adopted by the authority having jurisdiction is the edition intended as reference throughout the Section Text.

a. Factors indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
b. Coordinate design wind-load calculations with seismic load calculations for equipment requiring both seismic and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.

2. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:

a. PART 1: Low-Rise Buildings.
b. PART 2: Low-Rise Buildings (Simplified).
c. PART 3: Buildings with "h" less than 60 ft.
d. PART 4: Buildings with "h" greater than 60 ft. and less than 160 ft.
e. PART 5: Open Buildings.

3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7, Ch 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.

a. Risk Category: III.
b. h = Mean Roof Height: As indicated on Project Drawings.
c. V = Basic Wind Speed: Determined by Delegated Design Contractor based on Project Location and ASCE/SEI 7, Section 26.5 or standard design parameters from Authority Having Jurisdiction.
d. Kd = Wind Directionality Factor: Determined by Delegated Design Contractor based on Project Drawings and ASCE/SEI 7, Section 26.6 and Table 26.6-1.

e. Exposure Category: Determined by Delegated Design Contractor based on Project Location and ASCE/SEI 7, Section 26.7.
f. Kzt = Topographic Factor: Determined by Delegated Design Contractor based on Project Drawings and ASCE/SEI 7, Section 26.8 and Table 26.8-1.
g. Ke = Ground Elevation Factor: Determined by Delegated Design Contractor based on Project Drawings and ASCE/SEI 7, Section 26.8 and Table 26.8-1.
h. Kz = Velocity Pressure Exposure Coefficient (Evaluated at Height z): Determined by Delegated Design Contractor based on Project Drawings and ASCE/SEI 7, Section 26.10.1.
i. Kh = Velocity Pressure Exposure Coefficient (Evaluated at Height h): Determined by Delegated Design Contractor based on Project Drawings and ASCE/SEI 7, Section 26.10.1.
j. qz = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7 Section 26.10.1 or other source approved by authorities having jurisdiction.
k. qh = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7 Section 26.10.1 or other source approved by authorities having jurisdiction.
l. G = Gust-Effect Factor: 0.85 or as determined by Delegated Design Contractor based on Project Drawings and ASCE/SEI 7, Section 26.11.
m. Enclosure Classification: Determined by Delegated Design Contractor based on Project Drawings and ASCE/SEI 7, Section 26.12.
n. GCpi = Internal Pressure Coefficient: Determined by Delegated Design Contractor based on Project Drawings and ASCE/SEI 7, Table 26.13-1.

D. Consequential Damage: Provide additional seismic and wind-load restraints for suspended fire-suppression system components or anchorage of floor-, roof-, or wall-mounted fire-suppression system components as indicated in ASCE/SEI 7 so that failure of a non-essential or essential fire-suppression system component will not cause the failure of any other essential architectural, mechanical, or electrical building component.

E. Fire/Smoke Resistance: Seismic and wind-load-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723 and be so labeled.

F. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7 Section 13.6.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.

3. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
4. Surface Pattern: Smooth, ribbed, or waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.

    a. Surface Pattern: Smooth, ribbed, or waffle pattern.
    b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1. 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.

2. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

    a. Housing: Cast-ductile iron or welded steel.
    b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

2.6 SNUBBERS

A. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 for 2018 IBC.
2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.7 RESTRAINTS - RIGID TYPE

A. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.8 RESTRAINTS - CABLE TYPE

A. Seismic-Restraint Cables: ASTM A1023/A12023M galvanized, ASTM A603 galvanized-steel, or ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

B. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.9 RESTRAINT ACCESSORIES

A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid restraint and restraint cables.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.10 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Adhesive anchor bolts are unacceptable.

C. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7, Ch. 13.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

2.11 CONCRETE INSERTS

A. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

B. Comply with ANSI/MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation, wind control, and seismic 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.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Project Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry calculated static, wind load, and seismic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION CONTROL, WIND-LOAD-RESTRAINT, AND SEISMIC RESTRAINT DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Fire-Suppression Vibration Isolation, Seismic, and Wind-Load-Restraint Schedule, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraint and wind-load-restraint devices for systems and equipment where indicated in Equipment Schedules or Vibration Isolation, Seismic, and Wind-Load-Restraint Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points.

D. Installation of vibration isolators, wind-load restraints, and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.

E. Comply with installation requirements of NFPA 13 for installation of all seismic-restraint devices.

F. Comply with requirements in Section 077200 "Roof Accessories" for installation of equipment supports and roof penetrations.

G. Equipment Restraints:

1. Install snubbers on fire-suppression equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

H. Piping Restraints:

1. Comply with all requirements in NFPA 13.

2. Design piping sway bracing in accordance with NFPA 13.

    a. Maximum spacing of all sway bracing to be no greater than indicated in NFPA 13.
    b. Design loading of all sway bracing not to exceed values indicated in NFPA 13.

I. Install seismic- and wind-load-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Do not use adhesive-type anchor bolts.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross structural seismic joints and other points where differential movement may occur, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 211313 "Wet-Pipe Sprinkler Systems" for piping flexible connections.

3.5 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.6 FIELD QUALITY CONTROL

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

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

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with CAWCD, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
3. Obtain CAWCD's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at no fewer than four of each type and size of installed anchors and fasteners selected by CAWCD.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.

D. Remove and replace malfunctioning units and retest as specified above.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 210548

SECTION 210800 - COMMISSIONING OF FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Cx process requirements for the following fire-suppression systems, assemblies, and equipment:

1. Water-based fire-suppression systems.
2. Fire-extinguishing systems.
3. Fire pumps.

1.2 COMMISSIONING DESCRIPTION

A. Fire Suppression commissioning process includes the following tasks:

1. Testing and startup of fire suppression equipment and systems.
2. Equipment and system verification checks.
3. Assistance in functional performance testing to verify equipment and system performance.
4. Provide qualified personnel to assist in commissioning tests.
5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
7. Provide operation and maintenance information, list of PM tasks, recommended frequency, any instructions or diagrams needed to do the maintenance task, and record drawings to Commissioning Authority for review verification and organization, prior to distribution. Provide a detailed list of any spare parts, consumables, or special tools that may be needed for long-term maintenance.
8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
9. Provide training for systems specified in this Section with coordination by Commissioning Authority.

B. Equipment and Systems to Be Commissioned:

1. New fire suppression systems and equipment that were installed under this Contract.
2. Existing fire suppression systems that were modified, adjusted, upgraded, or affected by the work performed under this Contract.

C. The following is a partial list of equipment and systems that may be included in this fire suppression Commissioning:

1. Wet fire sprinkler system
2. Dry fire sprinkler system

3. Pre-action fire sprinkler system
4. Deluge fire sprinkler system
5. Standpipe system
6. Carbon dioxide extinguishing system
7. Clean agent extinguishing system
8. Fire pumps, motors, accessories, and controls.
9. Pressure-maintenance pumps, motors, accessories, and controls.

1.3 SUBMITTALS

A. Draft Forms: Submit draft of system verification form and functional performance test checklist tailored to the project specifics of this contract.

B. Certificate of Readiness: Signed by the contractor, certifying that the fire suppression systems, assemblies, equipment, and associated controls are ready for testing.

C. Commissioning Reports:

1. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified. Use NFPA forms as guidelines.
2. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.

D. Certificate of Completion: Certifying that the installation, prestart checklists, and startup procedures on all equipment in scope has been completed.

E. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning. Commissioning Authority is to work with contractors on the installation progress and is ultimately responsible for ensuring that the Contractor has accurately updated Record Documents to as built conditions. Commissioning Authority shall notify CAWCD in the event commissioning necessitates changes in the project record drawings.

F. Operation and Maintenance Data: Commissioning Authority to work with Contractor to provide final Fire Suppression Commissioning package with the final O&M Documents submitted to CAWCD. Provide a list of any ‘as left’ setpoints and other similar metrics if they aren’t already provided elsewhere or in the O&M manuals.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ACG, ASHRAE Guideline 1, NEBB, or TABB requirements. Forms to be approved by engineer.

1.5 QUALIFICATIONS

A. Commissioning Authority: A certified commissioning authority (CxA) by the AABC Commissioning Group (ACG) or approved by CAWCD.

1.6 COMMISSIONING RESPONSIBILITIES

A. General Contractor Commissioning Responsibilities

1. Retain services for an independent qualified 3rd party Commissioning Authority. CAWCD to provide approval of Commissioning Agency selected prior to GMP. CAWCD retains the right to hire the 3rd party Commissioning Authority.
2. Provide CAWCD a schedule of commissioning activities and meetings including (but not limited to) the items outlined in Article 1.8.
3. Delivery of plans, submittals, system manuals, and any other equipment-related information for the Commissioning Authority to review prior to field commissioning.
4. 3rd party Commissioning Authority shall have prior commissioning experience focused on Fire Protection and Suppression Systems.

B. Equipment or System Installer Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Ensure controls installer performs assigned commissioning responsibilities as specified below.
3. Provide instructions and demonstrations for CAWCD's personnel.
4. Ensure subcontractors perform assigned commissioning responsibilities.
5. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
6. Develop startup and initial checkout plan using manufacturer’s startup procedures and functional performance checklists for equipment and systems to be commissioned.
7. During verification check and startup process, execute plumbing related portions of checklists for equipment and systems to be commissioned.
8. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
9. Provide manufacturer’s representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.
10. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
11. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
12. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
13. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
14. Provide factory supervised startup services for equipment and systems. Coordinate work with manufacturer and Commissioning Authority.
15. Perform verification checks and startup on equipment and systems as specified.
16. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
17. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
18. Conduct fire suppression system orientation and inspection.

1.7 COMMISSIONING MEETINGS

A. Coordinate all commissioning meetings and progress commissioning meetings with the General Contractor, Fire Suppression Contractor, Commissioning Authority, and CAWCD.

1.8 SCHEDULING

A. Commissioning Authority to attend pre-installation meetings prior to any fire suppression work being performed. Contractor should have Commissioning Authority under contract prior to any fire suppression installations.

B. Prepare schedule indicating anticipated start dates for the following:

1. Piping system pressure testing.
2. Piping system flushing and cleaning.
3. Equipment and system startups.
4. Fire suppression system orientation and inspections.
5. Operation and maintenance manual submittals.
6. Training sessions. Provide two weeks' notice of training sessions for CAWCD staff.

1.9 COORDINATION

A. Notify CAWCD Project Engineer and Project Manager a minimum of four weeks in advance of the following:

1. Scheduled equipment and system startups.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Perform Cx process for fire-suppression system in accordance with NFPA 3.

3.2 TESTING PREPARATION

A. Certify that fire-suppression systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

B. Certify that fire-suppression system instrumentation and control systems have been completed and calibrated, that they are operating in accordance with the Contract Documents and approved submittals, and that pretest set points have been recorded.

C. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (for example, normal shutdown, normal auto position, normal manual position, emergency power, and alarm conditions).

3.3 INSTALLATION

A. Install additional valves, access doors, test ports, and pressure taps required to meet performance requirements.

B. Place fire suppression systems and equipment into full operation and continue operation during each working day of commissioning.

3.4 FIELD TESTS AND INSPECTIONS

A. Be responsible to participate in initial test of systems required to demonstrate performance.

END OF SECTION 210800

SECTION 211313 – WET PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Alarm devices.
6. Pressure gauges.

1.2 REFERENCES

A. National Fire Protection Association

1. NFPA 13 Standard for the Installation of Sprinkler Systems

1.3 SYSTEM DESCRIPTION

A. Sprinkler System to provide coverage for building areas as noted on drawings.

B. Standpipe system to provide fire hose valves in stair risers for fire department use as noted on drawings.

C. Provide hydraulically designed system to NFPA 13 hazard occupancy requirements as shown on drawings.

D. Determine volume and pressure of incoming water supply from water flow test data. Make determination if water supply is adequate for anticipated sprinkler system and if water supply modifications are required.

E. Interface system with building fire alarm and vertical pressurization system.

F. Provide fire department connection and fire pump test station as indicated on drawings.

1.4 ACTION SUBMITTALS

A. Product Data (PD):

1. For all products listed in Part 2, include manufacturers catalog information, performance ratings, rough-in details, weights, support requirements, and piping connections.

B. Shop Drawings (SD):

1. Shop drawings including plans, elevations, sections, panel wiring diagrams, riser diagrams and details will be prepared by the Contractor and signed and sealed by a Fire Protection Engineer registered in the state of Arizona.

C. General (G):

1. Samples: Two of each style of sprinkler specified.

D. Quality Control Reports (QCR):

1. Manufacturer's Certificate: Products meet or exceed specified requirements.
2. Design Data: Calculations; signed and sealed by professional engineer.
3. Soldering qualification certificates.
4. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. A detailed description of the systems.
2. A detailed description of routine maintenance required or recommended, or which would be provided under a maintenance contract including a maintenance schedule and detailed maintenance instructions for each type of device installed
3. Manufacturer's Data Sheets and Installation Manuals/Instructions for all equipment installed.
4. A list of recommended spare parts.
5. Service Directory.

B. Record Drawings:

1. The Contractor shall provide and maintain on the site an up-to-date record set of approved shop drawing prints which shall be marked to show all changes made to the sprinkler system from the original approved Shop Drawings. This shall not be construed as authorization to deviate from or make changes to the shop drawings approved by CAWCD without written instruction from CAWCD in each case. This set of drawings shall be used only as a record set.
2. Upon completion of the Work, the record set of prints shall be used to prepare complete, accurate final record drawings reflecting all changes and deviations made to the sprinkler system.
3. CAWCD, at their option and at the Contractor's expense, may require revised hydraulic calculations depending on the extent and nature of field changes.
4. The Record Drawings and Hydraulic Calculations shall have the signed stamp of a registered Professional Engineer, or as approved by CAWCD certifying the Record Drawings and the Hydraulic Calculations accurately represent the completed Fire Protection System.

1.6 QUALITY ASSURANCE

A. Perform Work according to NFPA 13.

B. Design system under direct supervision of professional fire protection engineer experienced in design of this Work and licensed in State of Arizona.

C. Soldering Qualifications: Qualify procedures and operators according to AWS B2.3.

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

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five years documented experience and approved by manufacturer.

1.8 WARRANTY

A. Manufacturer: Furnish two-year manufacturer warranty for all installed equipment.

B. Contractor:

1. Guarantee: The Contractor shall guarantee all materials and workmanship for a period of one (1) year beginning with the date of final acceptance by CAWCD. The Contractor shall be responsible during the design, installation, testing and guarantee periods for any damage caused by them (or their subcontractors) or by defects in their (or their subcontractor's) work, materials, or equipment.
2. Emergency Service: During the installation and warranty period, the Contractor shall provide emergency repair service for the sprinkler system within four (4) hours of a request by CAWCD for such service. This service shall be provided on a twenty-four (24) hour per day, seven (7) days per week basis.

1.9 MAINTENANCE

A. Furnish extra sprinklers under provisions of NFPA 13.

B. Furnish suitable wrenches for each sprinkler type.

C. Furnish metal storage cabinet in fire pump room.

PART 2 - PRODUCTS

2.1 Sprinkler Heads:

A. See drawings for sprinkler head locations and types.

B. Suspended Ceiling:

1. Type: Standard pendant type with matching push on escutcheon plate
2. Head Finish: Chrome Plated
3. Escutcheon Plate Finish: Chrome plated
4. Fusible Link: Fusible glass bulb link type temperature rated for specific area hazard.

C. Exposed Area Type:

1. Type: Standard upright type
2. Head Finish: Brass
3. Fusible Link: Glass bulb fusible link type temperature rated for specific area hazard.

D. Sidewall Type:

1. Type: Standard horizontal sidewall type (with matching push on escutcheon plate and guard where branch piping is concealed).
2. Head Finish: Brass
3. Escutcheon Plate Finish: Brass
4. Fusible Link: Glass bulb fusible link type temperature rated for specific area hazard.

E. Guard: For pendent and sidewall sprinklers located within 7 feet of the floor or subject to mechanical damage shall be provided with sprinkler guard with finish to match sprinkler head. Refer to drawings for sprinkler heads requiring wire guards.

F. Provide sprinkler heads with a temperature rating per NFPA 13 and as indicated on drawings.

G. Sprinkler head K factor should be selected to optimize the hydraulics of the fire sprinkler system. A minimum K factor of 5.6 is to be used. Refer to sprinkler head legends on drawings for sprinkler head K factors.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type K water tube, drawn temper.

B. Cast-Copper Fittings: ASME B16.18, pressure fittings.

C. Wrought-Copper Fittings: ASME B16.22, pressure fittings.

D. Pressfit Copper Fittings: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of ASME B16.51 and IAPMO PS 117 (IAPMO PS 117 is not for B75).

E. Copper Press Fittings: Fitting shall conform to ASME B16.18, ASME B16.22, or ASME B16.26.

F. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

G. Di-Electric Pipe Connection: Gruvlok DI-LOK Nipple or approved equivalent.

H. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

I. Copper-Tube, Extruded-Tee Connections:

1. Description: Tee formed in copper tube according to ASTM F 2014.

J. Copper Adapters:

1. Description: Adapters according to ASTM B 1622.

2.3 PIPING JOINING MATERIALS

A. Copper pipe shall be soldered with Stay-Brite® 8 in accordance with ASTM B32.

B. Sealing elements for copper press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by the fitting manufacturer. Press ends shall have Smart Connect ® technology. Viega Pro-Press, UL 213, FM Class 1920, Rubber Gasket Press Fittings or as approved by CAWCD.

C. Flanges:

1. Class 150, Bronze Flat-face Flanges, Full face, rubber, flat face, 1/8" thick.
2. Class 150, 2-Piece solder pressure combination flanges, Nibco Model 672, or CAWCD approved equal.
3. Class 150, Flange adapter for copper tubing, Victaulic Model 641, or CAWCD approved equal.

D. Grooved couplings and mechanical fittings shall be UL listed or FM approved for fire protection service.

E. Threaded Joint Compound: Teflon tape or approved joint compound.

2.4 SPECIALTY VALVES

A. Pressure Reducing Valve

1. The Pressure Reducing Valve shall be a single seated, line pressure operated, diaphragm actuated, pilot controlled, globe valve. The valve shall seal by means of a corrosion-resistant seat and resilient, rectangular seat disc.
2. The main valve body shall be Ductile Iron ASTM A 536 or as approved by CAWCD. The stem of the basic valve shall be guided top and bottom by integral bushings.
3. All internal and external ferrous surfaces shall be coated with a high quality, fusion epoxy coating.
4. The pilot control system shall consist of a two-way, normally open, direct acting, adjustable spring loaded, diaphragm actuated pressure reducing pilot. The pilot control system shall be protected with a “wye” type strainer off the supply line.
5. The pilot control shall be field adjustable to 60 psi.
6. Standard UL 1468.

B. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements. Provide automatic drain valves as indicated on drawings.
2. Standard: UL 1726.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. Connection Type: Threaded or soldered.

C. Relief Valves:

1. Relief valve as shown on drawings.
2. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

D. Flush-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements. Provide fire-department connection as indicated on drawings.
2. Standard: UL 405.
3. Type: Flush, for wall mounting.
4. Body Material: Corrosion-resistant metal.
5. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
6. Caps: Brass, lugged type, with gasket and chain.
7. Escutcheon Plate: Rectangular, brass, wall type.
8. Outlet: With pipe threads. Contractor to verify threads with local fire department.
9. Body Style: Horizontal.
10. Number of Inlets: Two (2).
11. Outlet Location: Exterior wall facing forebay.
12. Escutcheon Plate Marking: Similar to "AUTO SPKR. & STANDPIPE"
13. Finish: Rough brass or bronze.
14. Outlet Size: NPS 4.

2.5 ALARM DEVICES

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

B. Electrically Operated Alarm Bell:

1. Manufacturers: Subject to compliance with requirements. Provide bell as indicated on drawings.
2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 10-inch minimum diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

C. Horn and Strobe:

1. Manufacturers: Subject to compliance with requirements. Provide horn and strobe as indicated on drawings.
2. Standard: UL 464.
3. Tone: Selectable, steady, Temporal-3 (T-3), 2400 Hz, electromechanical, broadband.
4. Effective Intensity: 110 Cd.
5. Finish: Red, suitable for outdoor use. White letters on housing shall identify device for “Fire”.

D. Water-Flow Detectors:

1. Manufacturers: Subject to compliance with requirements, provide Potter flow switch or equivalent or as indicated on drawings.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two (2) single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig minimum.
7. Design Installation: Vertical.

E. Valve Supervisory Switches:

1. Valve supervisory switches not required by AHJ and shall not be provided. Valves to be locked in accordance with CAWCD standards.

2.6 PRESSURE GAUGES

A. Provide pressure gates gauges as indicated on drawings.

1. Standard: UL 393.
2. Dial Size: 3-1/2- to 4-1/2-inch diameter.
3. Pressure Gauge Range: 0 to 250 psig minimum.
4. Water System Piping Gauge: Include "WATER" or "AIR/WATER" label on dial face.

2.7 FIRE HOSE VALVE CONNECTIONS

A. Hose Outlet Valves: 300 PSIG, 2-1/2-inch, rough chrome plated, pressure regulating, brass angle valve with external threads having the NH standard thread, for the 2-1/2 inch valve, as specified in NFPA 1963. Provide with cap and chain finished to match valve.

2.8 BASIC SUPPORTS AND ANCHORS

A. General: Provide supports and anchors for fire protection system in compliance with NFPA 13.

1. Adjustable steel clevis hangers, adjustable steel band hangers, or adjustable band hangers, for horizontal-piping hangers and supports.
2. Two-bolt riser clamps for vertical piping supports.
3. Steel turnbuckles and malleable iron sockets for hanger-rod attachments.
4. Concrete inserts, top-beam C-clamps, side beam or channel clamps or center beam clamps for building attachments.
5. Concrete inserts and other type hangers penetrating into or through structural members shall be submitted by the Fire Protection Contractor for approval by the Structural Engineer contracted for this project.
6. Powder driven studs shall not be allowed.
7. Products: ITT Grinnell, Anvil, Eaton, or as approved by CAWCD.

2.9 SEISMIC RESTRAINTS

A. Seismic Performance: Supports, hangers, and braces shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Risk Category III
2. Seismic Design Category E
3. Component Importance Factor of 1.5
4. Products: Eaton Seismic Bracing or as approved by CAWCD.

PART 3 - EXECUTION

3.1 WATER-SUPPLY CONNECTIONS

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

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawings indicate general location and arrangement of piping. Install piping as indicated, as far as practical. The Contractor will be required to coordinate the piping as needed. Deviations from the approved drawings will require written approval from CAWCD.

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

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

D. Use UL Listed or FM Global Approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

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

F. Provide dielectric union where joining piping consisting of different piping materials.

G. Install soldered flange adapters for piping connection on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections. Install couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

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

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

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

K. Drains shall be piped to discharge to drain, and the discharge shall be visible by a sight drain fitting.

L. Concrete splash blocks, 18" x 18" x 4" minimum in size shall be installed under each drain or test outlet.

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

N. Install alarm devices in piping systems.

O. Install hangers and supports for sprinkler system piping according to NFPA 13. Hanger materials are to be designed for use with copper tube and to prevent electrolysis. Where hangers are used to support piping of material other than copper, un-lined and uncoated pre-galvanized hanger materials are acceptable.

P. Install hangers straight and true and piping parallel to building lines.

Q. All NFPA 13 sprinkler risers shall be installed vertically, unless approved otherwise by CAWCD. Riser components shall be located to be easily accessible for maintenance and inspection

R. Install pressure gauges on riser. Include pressure gauges with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and installation where they will not be subject to freezing.

S. Install guards on all pendent and sidewall sprinklers located within 7 feet of the floor or subject to mechanical damage, with finish to match sprinkler head.

T. Fill sprinkler system piping with water.

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210500 "Common Work Resulting from Fire Suppression."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210500 "Common Work Resulting from Fire Suppression."

W. All penetrations through fire-resistance rated construction (walls, floors, ceilings, etc.) are required to be sealed with UL listed assemblies as required to maintain the integrity of the fire-resistance rating. Contractor is required to submit all proposed UL listed fire-resistance rated assemblies for piping/ductwork penetrations to Engineer for review and approval prior to installation. Refer to Section 078400 “Firestopping”.

3.3 JOINT CONSTRUCTION

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

B. Install couplings for grooved-end piping on valves, apparatus, and equipment having NPS 3 and larger end connections.

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

D. Coat threaded ends with pipe-lubricant compound.

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

F. End Treatment: After cutting pipe lengths, remove burrs and fins from pipe ends.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install UL Listed or FM Global Approved fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and the specifications.

B. Install UL Listed or FM Global Approved fire-protection shutoff valves chained open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Provide drain valves at main shutoff valves, and at low points of piping and apparatus.

D. Provide gate valves for shutoff or isolating service. (Where approved, butterfly valves may be used instead of gate valves.)

3.5 INSTALLATION – ALARM BELL

A. Locate outside alarm bell on building wall as indicated on the drawings.

3.6 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels. Locate at center or quarter point in 2 feet X 4 feet tiles.

B. Sprinkler heads shall be positioned in compliance with NFPA 13 for any obstructions.

C. Run piping concealed above ceilings in areas with dropped ceilings to extent possible. Expose only sprinkler heads.

D. Install sprinkler piping in a manner such that mechanical equipment, ceiling tiles or lights can be accessed and easily removed.

3.7 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire-department connections.

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

C. Install mechanical sleeve seal at pipe penetration in outside walls.

3.8 IDENTIFICATION

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

B. Label all new wet-pipe sprinkler system piping in accordance with ANSI/ASME A13.1-2007.

C. Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Valve identification signs shall be minimum 6 inches wide x 2 inches high with enamel baked finish on minimum 18-gauge steel or 0.024-inch aluminum with red letters on a white background or white letters on red background.

D. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13 and shall include the minimum following design data:

1. Building designation
2. Location of remote area
3. Design Density
4. Area of application
5. System demand (gpm and psi at base of riser)

E. Each control valve shall be labeled to indicate the shutoff zone and area as indicated on the drawings.

F. All manual valves shall be tagged with stainless steel tag and chain, with valve number as indicated on drawings.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Start and run excess-pressure pumps.
6. Coordinate with fire-alarm tests. Operate as required.

C. The fire protection piping shall be tested under a hydrostatic pressure of not less than 200 PSIG, for a duration of not less than two (2) hours.

D. Sprinkler piping system will be considered defective if it does not pass tests and inspections. Replace piping system components which do not pass the test procedures specified, and retest repaired portion of the system at the Fire Protection Contractor’s expense.

E. Prepare test and inspection reports.

3.10 CLEANING

A. Following assembly and testing, and prior to final acceptance, piping systems shall be flushed with water to remove accumulated construction debris and other foreign matter. The piping shall be flushed until all foreign matter is removed from the pipeline. Provide all hoses, temporary pipes, and other items as required to properly dispose of flushing water without damage to adjacent equipment. The minimum flushing quantities are specified in NFPA 13.

B. Clean dirt and debris from sprinklers.

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

D. Remove and replace any sprinklers damaged during construction.

3.11 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Type K, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints; flanged joints.

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

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller piping, shall be the following:

1. Type K, hard copper tube with plain ends; wrought-copper solder-joint, threaded, or pressed fittings; and Stay-Brite® 8 solder joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 6, shall be the following:

1. Type K, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints; flanged joints.

3.12 SYSTEM CERTIFICATION

A. The Contractor shall provide CAWCD with written certification prior to final inspection, that all new equipment:

1. Has been visually inspected and functionally tested as required by the specifications.
2. Is installed entirely in accordance with the manufacturer’s recommendations within the limitations of the system’s UL listings and NFPA criteria.
3. Is in proper working order.

3.13 FINAL INSPECTION AND TESTING

A. The Contractor shall make arrangements with CAWCD for final inspection and witnessing of the final acceptance tests. The Fire Protection Contractor, the Alarm System Contractor and CAWCD will conduct the final inspection and witness the final acceptance test.

B. All tests and inspections required by the referenced Codes, Standards, and CAWCD shall be performed by the Contractor.

C. The inspecting committee as referenced above will visit the job site to inspect the work and witness the final acceptance tests when they have been advised by the Contractor that the work is completed and ready for test. If the Work is not complete or the test is unsatisfactory, the Contractor shall be responsible for the Consultant's extra time and expenses for re-inspection and witnessing the re-testing of the work. Such extra fees shall be deducted from payments by CAWCD to the Contractor.

D. After the system has been inspected and tested, a certificate, "Contractor's Material and Test Certificate for Aboveground Piping", shall be provided by the Contractor and shall be signed by him or his representative and CAWCD. Sufficient copies shall be prepared to ensure the Engineer, CAWCD, all Inspecting Authorities and the Contractor have a copy for their files. The Contractor shall prepare one (1) test report for each inspection performed whether successful or not.

E. Contractor shall provide at least five (5) working days’ notice for all tests.

F. All sprinkler supervisory initiating devices shall be functionally tested to verify proper operation.

G. All supervisory functions of each initiating device shall be functionally tested.

3.14 TRAINING

A. Contractor shall conduct two (2) training sessions of four (4) hours each to familiarize the building personnel with the features, operation, and maintenance of the sprinkler systems. Training sessions shall be scheduled by the contractor at a time mutually agreeable to the Contractor and CAWCD.

3.15 WATER DAMAGE

A. The Fire Protection Contractor shall be responsible for any damage to the work of others, to building and property/materials of others caused by leaks in automatic sprinkler equipment, unplugged or disconnected pipes or fittings, and shall pay for necessary replacement or repair of work or items so damaged during the installation and testing periods of the automatic sprinkler work.

END OF SECTION 211313

SECTION 211326 – DELUGE FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Alarm devices.
6. Pressure gauges.

1.2 SYSTEM DESCRIPTION

A. System to provide coverage for building areas as noted on drawings.

B. Provide hydraulically designed system to NFPA 13 hazard occupancy requirements as shown on drawings.

C. Determine volume and pressure of incoming water supply from water flow test data. Make determination if water supply is adequate for anticipated sprinkler system and if water supply modifications are required.

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

E. Provide fire department connection and fire pump test station as indicated on drawings.

1.3 ACTION SUBMITTALS

A. Product Data (PD):

1. All products listed in Part 2 shall include manufacturers catalog information, performance ratings, rough-in details, weights, support requirements, and piping connections.

B. Shop Drawings (SD):

1. Shop drawings including plans, elevations, sections, panel wiring diagrams, riser diagrams and details will be prepared by the Contractor and signed and sealed by a Fire Protection Engineer registered in the state of Arizona.

C. General (G):

1. Samples: Two of each style of sprinkler specified.
2. Floor and wall penetrations must be marked, reviewed, and agreed to by CAWCD and Core Drilling permit obtained prior to any core drilling.

D. Quality Control Reports (QCR):

1. Manufacturer's Certificate: Products meet or exceed specified requirements.
2. Design Data: Calculations; signed and sealed by professional engineer.
3. Soldering qualification certificates (as required).
4. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. A detailed description of the systems.
2. A detailed description of routine maintenance required or recommended, or which would be provided under a maintenance contract including a maintenance schedule and detailed maintenance instructions for each type of device installed
3. Manufacturer's Data Sheets and Installation Manuals/Instructions for all equipment installed.
4. A list of recommended spare parts.
5. Service Directory.

B. Record Drawings:

1. The Contractor shall provide and maintain on the site an up-to-date record set of approved shop drawing prints which shall be marked to show all changes made to the sprinkler system from the original approved Shop Drawings. This shall not be construed as authorization to deviate from or make changes to the shop drawings approved by CAWCD without written instruction from CAWCD in each case. This set of drawings shall be used only as a record set.
2. Upon completion of the Work, the record set of prints shall be used to prepare complete, accurate final record drawings reflecting all changes and deviations made to the sprinkler system.
3. CAWCD, at their option and at the Contractor's expense, may require revised hydraulic calculations depending on the extent and nature of field changes.
4. The Record Drawings and Hydraulic Calculations shall have the signed stamp of a registered Professional Engineer or the signature with certification number of a Level 4 Senior Engineering Technician of the National Institute for Certification of Engineering Technology certifying the Record Drawings and the Hydraulic Calculations accurately represent the completed Fire Protection System.

1.5 QUALITY ASSURANCE

A. Perform Work according to NFPA 13 and NFPA 15 as applicable.

B. Design system under direct supervision of professional engineer experienced in design of this Work and licensed in State of Arizona.

C. Soldering Qualifications: Qualify procedures and operators according to AWS B2.3.

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

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five years documented experience and approved by manufacturer.

1.7 WARRANTY

A. Manufacturer: Furnish two-year manufacturer warranty for all installed equipment.

B. Emergency Service: During the installation and warranty period, the Contractor shall provide emergency repair service for the sprinkler system within four (4) hours of a request by CAWCD for such service. This service shall be provided on a twenty-four (24) hour per day, seven (7) days per week basis.

1.8 MAINTENANCE

A. Furnish extra nozzles under the provisions of NFPA 13.

B. Furnish suitable wrenches for each sprinkler type.

C. Furnish metal storage cabinet in fire pump room.

PART 2 - PRODUCTS

2.1 Sprinkler Heads:

A. See drawings for sprinkler head locations and types.

B. Exposed Area Type:

1. Type: Nozzle – Fixed Stream Type as noted
2. Head Finish: Brass

2.2 STEEL PIPE AND FITTINGS

A. Steel Piping shall be used for pressures greater than 175 psi.

B. Steel Pipe: ASTM A 53, A795 or A135, Schedule 40, Black or Galvanized steel pipe.

C. Cast Iron Threaded Fittings: ANSI B16.4, Class 125 standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

D. Malleable Iron Threaded Fittings: ANSI B16.3, Class 300, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1. Install steel pipe with threaded joints and fittings for 2-inch and smaller and where shown on drawings.

E. Grooved Mechanical Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47 Grade 32510 malleable iron; or ASTM A53, Type F or Types E or S.

F. Grooved Mechanical Couplings: Consist of ductile or malleable iron housing, a synthetic rubber gasket of a central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure roll-grooved pipe and fittings. Grooved mechanical couplings including gaskets used on dry-pipe systems shall be listed for dry-pipe service.

2.3 STEEL PIPING JOINING MATERIALS

A. Gasket Materials: Thickness, materials, and type suitable for fluid or gas to be handled, and design temperatures and pressures.

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

C. Grooved couplings and mechanical fittings shall be UL listed or FM approved for fire protection service.

D. Threaded Joint Compound: Teflon tape or approved joint compound.

2.4 COPPER TUBE AND FITTINGS

A. Copper Piping shall be used for pressures equal to or less than 175 psi.

B. Hard Copper Tube: ASTM B 88, Type K water tube, drawn temper.

C. Cast-Copper Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper Fittings: ASME B16.22, pressure fittings.

E. Pressfit Copper Fittings: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of ASME B16.51 and IAPMO PS 117 (IAPMO PS 117 is not for B75).

F. Copper Press Fittings: Fitting shall conform to ASME B16.18, ASME B16.22, or ASME B16.26.

G. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

H. Di-Electric Pipe Connection: Gruvlok DI-LOK Nipple or approved equivalent.

I. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

J. Copper-Tube Extruded-Tee Connections:

1. Description: If approved by CAWCD, tee formed in copper tube according to ASTM F 2014.

K. Copper Adapters:

1. Description: Adapters according to ASME B16.22.

2.5 COPPER PIPING JOINING MATERIALS

A. Copper pipe shall be soldered with Stay-Brite® 8 in accordance with ASTM B32.

B. Sealing elements for copper press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by the fitting manufacturer. Press ends shall have Smart Connect ® technology.

C. Flanges:

1. Class 150, Bronze Flat-face Flanges, Full face, rubber, flat face, 1/8" thick.
2. Class 150, 2-piece solder pressure companion flanges, Nibco Model 672, or CAWCD approved equal.
3. Class 150, Flange adapter for copper tubing, Victaulic Model 641, or CAWCD approved equal.

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

E. Grooved couplings and mechanical fittings shall be UL listed or FM approved for fire protection service.

F. Threaded Joint Compound: Teflon tape or approved joint compound.

2.6 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL-Listed or FM Global approved.
2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig or as required by project drawings.
3. All valves of the same type shall be provided by the same manufacturer.

B. Deluge Valves

1. Manufacturers: Subject to compliance with requirements. Provide deluge valves as indicated on drawings.
2. Standard: UL260
3. Pressure Rating 300 psig Minimum
4. Type: Diaphram
5. Body Material: Cast Iron
6. Connection Type: Flanged or grooved.

7. Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.

2.7 SPECIALTY VALVES

A. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements. Provide automatic drain valves as indicated on drawings.
2. Standard: UL 1726.
3. Pressure Rating: 175 psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. Connection Type: Threaded or soldered.

2.8 ALARM DEVICES

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

B. Electrically Operated Alarm Bell:

1. Manufacturers: Subject to compliance with requirements. Provide bell as indicated on drawings.
2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 10-inch minimum diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

C. Horn and Strobe:

1. Manufacturers: Subject to compliance with requirements. Provide horn and strobe as indicated on drawings.
2. Standard: UL 464.
3. Tone: Selectable, steady, Temporal-3 (T-3), 2400 Hz, electromechanical, broadband.
4. Effective Intensity: 110 Cd.
5. Finish: Red, suitable for outdoor use. White letters on housing shall identify device for “Fire”.

D. Water-Flow Detectors:

1. Manufacturers: Subject to compliance with requirements, provide Potter flow switch or equivalent or as indicated on drawings.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two (2) single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

5. Type: Pressure operated.
6. Pressure Rating: 300 psig.
7. Design Installation: Rising pressure to 6 psi (41 kPa), plus or minus 2 psi (13.8 kPa), signals water flow.

E. Valve Supervisory Switches:

1. Valve supervisory switches not required by AHJ. Valves to be locked in accordance with CAWCD standards.

2.9 PRESSURE GAUGES

A. Provide pressure gates gauges as indicated on drawings.

1. Standard: UL 393.
2. Dial Size: 3-1/2- to 4-1/2-inch diameter.
3. Pressure Gauge Range: 0 to 300 psig minimum.
4. Water System Piping Gauge: Include "WATER" or "AIR/WATER" label on dial face.

2.10 SEISMIC RESTRAINTS

A. Seismic Performance: Supports, hangers, and braces shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Risk Category III
2. Seismic Design Category E
3. Component Importance Factor of 1.5
4. Products: Eaton Seismic Bracing or as approved by CAWCD.

PART 3 - EXECUTION

3.1 WATER-SUPPLY CONNECTIONS

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

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawings indicate general location and arrangement of piping. Install piping as indicated, as far as practical. The Contractor will be required to coordinate the piping as needed. Deviations from the approved drawings will require written approval from CAWCD.

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

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

D. Use UL Listed or FM Global Approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

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

F. Provide dielectric union where joining piping consisting of different piping materials.

G. Install couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

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

I. Drains shall be piped to discharge to drain, and the discharge shall be visible by a sight drain fitting.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Where hangers are used to support piping of material other than copper, un-lined and uncoated pre-galvanized hanger materials are acceptable.

L. Install pressure gauges on riser. Include pressure gauges with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and installation where they will not be subject to freezing.

M. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210500 "Common Work Results for Fire Suppression."

N. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210500 "Common Work Results for Fire Suppression."

O. All penetrations through fire-resistance rated construction (walls, floors, ceilings, etc.) are required to be sealed with UL listed assemblies as required to maintain the integrity of the fire-resistance rating. Contractor is required to submit all proposed UL listed fire-resistance rated assemblies for piping/ductwork penetrations to Engineer for review and approval prior to installation. Refer to Section 078400 “Firestopping”.

3.3 JOINT CONSTRUCTION

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

B. Install couplings for grooved-end piping on valves, apparatus, and equipment having NPS 3 and larger end connections.

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

D. Coat threaded ends with pipe-lubricant compound.

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

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install UL Listed or FM Global Approved fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and the specifications.

B. Install UL Listed or FM Global Approved fire-protection shutoff valves chained open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Provide drain valves at main shutoff valves, and at low points of piping and apparatus.

D. Provide gate valves for shutoff or isolating service. (Where approved, butterfly valves may be used instead of gate valves.)

E. Provide “Normally Closed” butterfly valves downstream of each deluge valve to facilitate trip testing of valve without discharging water onto energized equipment.

3.5 INSTALLATION – ALARM BELL

A. Locate outside alarm bell on building wall as indicated on the drawings.

3.6 NOZZLE INSTALLATION

A. Install nozzles to provide complete wetting over surfaces of transformers.

3.7 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire-department connections.

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

C. Install mechanical sleeve seal at pipe penetration in outside walls.

3.8 IDENTIFICATION

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

B. Label all new wet-pipe sprinkler system piping in accordance with ANSI/ASME A13.1-2007.

C. Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Valve

identification signs shall be minimum 6 inches wide x 2 inches high with enamel baked finish on minimum 18-gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background.

D. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13 and shall include the minimum following design data:

1. Building designation
2. Location of remote area
3. Design Density
4. Area of application
5. System demand (gpm and psi at base of riser)

E. Each control valve shall be labeled to indicate the shutoff zone and area as indicated on the drawings.

F. All manual valves shall be tagged with stainless steel tag and chain, with valve number as indicated on drawings.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Start and run excess-pressure pumps.
6. Coordinate with fire-alarm tests. Operate as required.

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

D. Prepare test and inspection reports.

3.10 CLEANING

A. Following assembly and testing, and prior to final acceptance, piping systems shall be flushed with water to remove accumulated construction debris and other foreign matter. The piping shall be flushed until all foreign matter is removed from the pipeline. Provide all hoses, temporary pipes, and other items as required to properly dispose of flushing water without damage to adjacent equipment. The minimum flushing quantities are specified in NFPA 13.

B. Clean dirt and debris from sprinklers.

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

3.11 PIPING SCHEDULE

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

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

C. High-pressure (greater than 175 psi), wet pipe supply piping shall be the following:

1. ASTM A 53, A795 or A135, Schedule 40, Black steel pipe

a. NPS 2” and smaller, threaded or grooved ends
b. NPS 2½” and larger, flanged or grooved ends.

D. High-pressure (greater than 175 psi), dry-pipe sprinkler system shall be the following:

1. ASTM A 53, A795 or A135, Schedule 40, Galvanized steel pipe

a. NPS 2” and smaller, threaded or grooved ends
b. NPS 2½” and larger, flanged or grooved ends.

E. Standard-pressure (less than or equal to 175 psi), wet- or dry-pipe sprinkler system, NPS 2 and smaller piping, shall be the following:

1. Type K, hard copper tube with plain ends; wrought-copper solder-joint, threaded, or pressed fittings; and Stay-Brite® 8 solder joints.

F. Standard-pressure (less than or equal to 175 psi), wet- or dry-pipe sprinkler system, NPS 2-1/2 to NPS 6, shall be the following:

1. Type K, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints; flanged joints.

3.12 SYSTEM CERTIFICATION

A. The Contractor shall provide CAWCD with written certification prior to final inspection, that all new equipment:

1. Has been visually inspected and functionally tested as required by the specifications.
2. Is installed entirely in accordance with the manufacturer’s recommendations within the limitations of the system’s UL listings and NFPA criteria.
3. Is in proper working order.

3.13 FINAL INSPECTION AND TESTING

A. The Contractor shall make arrangements with CAWCD for final inspection and witnessing of the final acceptance tests. The Fire Protection Contractor, the Alarm System Contractor and CAWCD will conduct the final inspection and witness the final acceptance test.

B. All tests and inspections required by the referenced Codes, Standards, and CAWCD shall be performed by the Contractor.

C. The inspecting committee as referenced above will visit the job site to inspect the work and witness the final acceptance tests when they have been advised by the Contractor that the work is completed and ready for test. If the Work is not complete or the test is unsatisfactory, the Contractor shall be responsible for the Consultant's extra time and expenses for re-inspection and witnessing the re-testing of the work. Such extra fees shall be deducted from payments by CAWCD to the Contractor.

D. After the system has been inspected and tested, a certificate, "Contractor's Material and Test Certificate for Aboveground Piping", shall be provided by the Contractor and shall be signed by him or his representative and CAWCD. Sufficient copies shall be prepared to ensure the Engineer, CAWCD, all Inspecting Authorities and the Contractor have a copy for their files. The Contractor shall prepare one (1) test report for each inspection performed whether successful or not.

E. Contractor shall provide at least five (5) working days' notice for all tests.

F. All sprinkler supervisory initiating devices shall be functionally tested to verify proper operation.

G. All supervisory functions of each initiating device shall be functionally tested.

3.14 TRAINING

A. Contractor shall conduct two (2) training sessions of four (4) hours each to familiarize the building personnel with the features, operation, and maintenance of the sprinkler systems. Training sessions shall be scheduled by the contractor at a time mutually agreeable to the Contractor and CAWCD.

3.15 WATER DAMAGE

A. The Fire Protection Contractor shall be responsible for any damage to the work of others, to building and property/materials of others caused by leaks in automatic sprinkler equipment, unplugged or disconnected pipes or fittings, and shall pay for necessary replacement or repair of work or items so damaged during the installation and testing periods of the automatic sprinkler work.

END OF SECTION 211326

212200 – CLEAN-AGENT FIRE-EXTINGUISHING SYSTEM – SEVO Force500

PART 1 - GENERAL

1.1 SUMMARY

A. This specification outlines the requirements for a total flooding clean agent fire extinguishing system comprising of SEVO Systems FORCE500 equipment utilizing 3M™ Novec™ 1230 Fire Protection Fluid. All requirements outlined in this specification must be completed in their entirety. These requirements, which are in accordance with the items listed in Section 1.2, combined with good engineering practices shall be followed to produce a safe and effective clean agent fire extinguishing system.

1.2 SYSTEM DESCRIPTION

A. The clean agent fire extinguishing system shall perform as outlined in the following sub-sections.

1. Achieve a 4.5% (v/v) extinguishing concentration for Class A (Surface Type Fires) hazards.
2. Achieve 5.85% (v/v) or greater, as required, extinguishing concentration for Class B (Flammable Liquids) hazards.
3. Achieve a 4.5% (v/v) extinguishing concentration for Class C (Energized Electrical Equipment) hazards.
4. Within 4 seconds, the clean agent fire extinguishing system shall discharge 95% of the required suppression agent mass to maximize extinguishing and minimize damage from fire and decomposition byproducts during extinguishing.
5. The clean agent fire extinguishing system shall consist of one or more SEVO Systems agent cylinders and related equipment. The cylinders may be either connected to a discharge pipe arrangement separately or connected to a common manifold and discharge pipe arrangement. The agent cylinders shall be filled with Novec 1230 fluid, and super pressurized with dry nitrogen to a working pressure of 500 PSIG at 70°F (34.5 bar gauge at 21°C).

1.3 SYSTEM DESIGN CRITERIA

A. A total flooding clean agent fire extinguishing system, employing Novec 1230 fluid, shall be installed to meet a minimum design concentration of 4.5% by volume in all designated spaces to be protected.

1.4 ACTION SUBMITTALS

A. The engineer will review all submittals for conformance to the drawings and specifications. The contractor shall be required to resubmit any materials, with appropriate modifications, that are found to be in non-conformance with the requirements of the drawings and these specifications after review by the engineer.

Approval of the submittals by the engineer shall not relieve the Contractor of their responsibility to meet the requirements of the drawings and specifications.

B. Engineered Design Drawings: The Contractor shall provide all required documents including the following details:

1. The factory-authorized SEVO Systems Distributor shall provide all required installation drawings per NFPA 2001.

C. Flow Calculation Reports:

1. The distributor shall provide the following information in the flow calculation report.

a. Customer information and project data
b. Hazard information: At a minimum, hazard information shall include minimum design concentration, minimum enclosure ambient temperature, minimum agent required and volume of enclosures, and identify discharge nozzles by quantity and style.
c. Cylinder information: At a minimum, cylinder information shall include cylinder capacity, agent fill amount per cylinder and quantity of cylinders.
d. Pipe network information: At a minimum, pipe network information shall include pipe type, pipe diameter, pipe length, change in elevation, pipe equivalent length and any added accessory equivalent length. In addition, the following nozzle information shall be provided; number of nozzles and identification of enclosure location, flow rate of associated nozzle, nozzle nominal pipe size, nozzle type and nozzle orifice area.
e. Pipes and pipe fittings: At a minimum, pipe and fitting summary shall include a detailed list of pipe, by schedule, nominal diameter and length, and fittings, by Class Rating, nominal diameter and quantity.

D. Commissioning Equipment List: The distributor shall provide a commissioning equipment list for each installed clean agent fire extinguishing system. The equipment list shall identify all installed equipment and configurations.

E. Test Plan:

1. The distributor shall submit a test plan that describes how the system equipment and room integrity shall be tested. This shall include a step-by-step description of all tests and shall indicate type and location of test apparatus to be used. At a minimum, the tests to be conducted shall be per NFPA 2001 and any additional supplemental tests required by the AHJ. Tests shall not be scheduled nor conducted until the engineer of record approves the test plan.

F. Installation Drawings:

1. Four (4) sets of installation drawings for each installed clean agent fire extinguishing system and one (1) set of the calculation report, owner’s manual and product data sheets shall be submitted to CAWCD.
2. Upon completion of installation and commissioning acceptance, two (2) sets of “As-Built” installation drawings and One (1) set of the calculation report for each installed clean agent fire extinguishing system shall be given to CAWCD for use and reference.

G. Operation and Maintenance Manuals:

1. Two (2) copies of the SEVO Systems Design, Installation, Operation and Maintenance Manual for the clean agent fire extinguishing system employing Novec 1230 fluid shall be submitted after complete installation.

1.5 QUALIFICATIONS

A. Manufacturer:

1. The manufacturer/supplier of the system hardware and components shall have a minimum of ten (10) years' experience in the design and manufacture of systems of similar type
2. The manufacturer/supplier of the systems shall be in compliance and/or certified to ISO 9001 for a minimum period of five (5) years for the design, production and distribution of fire detection, fire alarm and fire suppression systems.
3. The name of the manufacturer/supplier and manufacturer part numbers shall appear on all major components.
4. All cylinders, valves and nozzles shall be manufactured in the United States.
5. All devices, components and equipment shall be the products of the same manufacturer/supplier.
6. The system manufacturer/supplier shall have the ability to provide multiple suppression system arrangements to accommodate the performance criteria required by the project.
7. All devices, components and equipment shall be listed by the standardizing agencies (UL and/or FM).

B. Contractor:

1. The distributor shall be trained by the manufacturer to calculate/design, install, test and maintain the clean agent fire extinguishing system employing Novec 1230 fluid and shall be able to produce a certificate stating such on request.
2. The installing contractor shall employ a person who can show proficiency at least equal to a NICET level III certification in special hazards design or manufactures approval level IV.
3. The Contractor shall confirm in writing that he stocks a full complement of spare parts and offers 24-hour emergency service for all equipment being furnished.
4. The Contractor shall have ability to refill a discharged system on site within 24 hours on site using SEVO Systems CAPS refill station.

1.6 WARRANTY

A. Components provided by the manufacturer shall carry a warranty of twelve (12) months from date of sale.

1.7 QUALIFIED CALCULATION

A. A qualified system calculation using listed and approved software must be provided demonstration the capability to provide for:

B. Piping Limitations:

1. Pipe Length before a tee split: minimum of 3.8 pipe diameters
2. Flow split at bull tee: 85%/15% maximum split 50%/50% minimum split
3. Flow split at side tee: 95%/5% maximum split 55%/45% minimum split
4. Minimum ceiling height: 12 in (30.5 cm)
5. Nozzles may be positioned from 7 ft (2.1m) from floor to 1 in (26mm) from ceiling
6. Nozzles can be positioned vertically up or vertically down

PART 2 - SUPPRESSION SYSTEM REQUIREMENTS

2.1 GENERAL

A. The clean agent fire extinguishing system shall consist of Novec 1230 fluid, agent storage cylinder(s), SEVO actuation hardware and SEVO discharge nozzle(s) attached to a pipe network.

2.2 SYSTEM PERFORMANCE

A. System Discharge:

1. The discharge time required to achieve 95% of the minimum design concentration for flame extinguishment shall be 3.5 seconds and not exceed 10 seconds.

B. Duration of Protection:

1. 85% of the minimum design concentration shall be maintained for 10-minutes or a sufficiently longer period of time to allow effective emergency action by trained personnel. A level 1 certification in room integrity testing, provided by a manufacturer of room integrity testing equipment and/or recognized by SEVO Systems is required.

C. Minimum System Design Limits

1. Nozzles:

a. Nozzles shall be listed and approved for a maximum ceiling height of 14 feet (4.27 m) and a minimum ceiling height of 1 foot (0.31 m).
b. Nozzle area coverage for both 360- and 180-degree nozzles shall be a maximum of 32 ft. x 32 ft. square (9.8 m x 9.8 m).
c. System Nozzles shall be listed and approved to accommodate a maximum arrival time of 2.0 seconds and a maximum run-out time of 6.3 seconds.
d. Install flow restriction
e. System Nozzles shall be listed and approved for a minimum of 73 PSIG (5 bar gauge) nozzle pressure.

2.3 PIPE AND FITTINGS

A. Distribution piping and fittings shall be installed in accordance with NFPA 2001, approved piping standards and the engineered fire suppression system manufacturer's requirements.

B. Piping Schedule:

C.

500 psi (34.5 bar) Flow Rates					
Pipe Diameter		Minimum Flow Rate		Maximum Flow Rate	
Inches	Millimeters	lb/s	kg/s	lb/s	kg/s
1/2	15.80	1.0	0.5	5.6	2.5
3/4	20.90	2.0	0.9	10.9	4.9
1	26.60	3.5	1.6	18.3	8.3
1 1/4	35.10	6.0	2.7	31.2	14.1
1 1/2	40.90	9.0	4.1	41.8	18.9
2	52.50	14.0	6.4	67.8	30.7
2 1/2	62.70	20.0	9.1	109.9	49.8
3	77.90	30.0	13.6	151.3	68.6
4	102.30	55.0	24.9	257.6	116.8
5	128.20	90.0	40.8	384.0	174.1
6	154.10	120.0	54.4	649.0	294.3

2.4 ACTUATION HARDWARE

A. The agent cylinders shall be actuated in accordance with the applicable design manual.

B. While in the stand-by condition, actuators attached to the cylinder valve shall not be exposed to the cylinder's internal pressure so as to avoid introducing additional leak paths or accidental discharges.

C. Solenoid actuators shall not require scheduled periodic replacement.

D. The suppression panel shall be UL Listed per UL 864, 9th Edition with the interfacing electric actuators.

2.5 NOZZLES

A. Total flooding clean agent extinguishing system nozzles shall be made of aluminum.

B. Each nozzle shall be located in the space per the manufacturer's guidelines. Nozzles shall have either a 180- or a 360-degree discharge pattern.

C. Each nozzle discharge pattern shall be available in sizes ranging from 1/2-in NPT to 2-1/2-in NPT.

D. Each nozzle size and style shall offer multiple different orifice areas by means of removable orifice plate; orifices determined per flow calculations. Minimum of 30 orifice diameters per nozzle size and style.

E. Nozzles shall be UL Listed and/or FM Approved for use with the manufacturer's clean agent extinguishing system employing Novec 1230 fluid.

2.6 AGENT CYLINDER ASSEMBLIES

A. Novec 1230 fluid shall be stored in cylinder manufactured and marked in accordance with US Department of Transportation (DOT) specification 4BW-500 and Transport Canada (TC) specification 4BW-M34. The agent cylinders shall be conditioned to 500 PSIG @ 70°F (34.5 bar gauge @ 21°C). The system manufacturer shall be able to provide US DOT documentation that the registration number marked on the agent cylinder corresponds to a manufacturing location at a US address.

1. Novec 1230 fluid cylinders shall be equipped with a pressure gauge to display internal pressures. The gauge shall be an integral part of the equipment and shall be color-coded for fast referencing of pressure readings.
2. A low-pressure switch shall be provided as standard equipment on the Novec 1230 fluid cylinders. This switch is to be integrated with the pressure gauge assembly. A decrease in pressure will cause the normally open/normally closed contacts to close/open, indicating a trouble condition at the control panel.
3. Novec 1230 fluid cylinders with capacities in excess of 164lb shall be equipped with an integral liquid level indicator (LLI). The LLI will allow the agent cylinder to remain connected and secured in place while measuring the agent mass.
4. A factory installed SEVO gauge guard shall be provided as standard equipment on all Novec 1230 fluid cylinders.
5. A pressure correction valve shall be included as standard equipment on all Novec 1230 fluid cylinders.
6. Novec 1230 fluid cylinders are not to exceed 910lb capacity in size.

PART 3 - EXECUTION

3.1 CLEAN AGENT FIRE EXTINGUISHING SYSTEM INSTALLATION

A. The system shall be supplied and installed by a factory-authorized, SEVO Systems Distributor. The Distributor shall be trained and certified by SEVO Systems to design, install and maintain the SEVO fire suppression system. The distributor shall install the system in accordance with the manufacturer's design, installation, operation and maintenance manual.

3.2 ELECTRICAL SYSTEM INSTALLATION

A. All electrical enclosures, raceways, and conduits shall be provided and installed in accordance with applicable codes and intended use and shall contain only those electrical circuits associated with the fire-detection and control system. No circuit or circuits that are unrelated to the fire alarm or suppression system shall be routed

through the enclosures, raceways, and conduits dedicated to the fire alarm or suppression system.

B. Splicing of circuits shall be kept to a minimum and is only permitted in an electrical box suitable for the purpose. Appropriate hardware shall be used to make the wire splices. Wires that are spliced together shall have the same color insulation.

C. White colored wire shall be used exclusively for the identification of the neutral conductor of an alternating-current circuit. Green colored wire shall be used exclusively for the identification of the earth-ground conductor of an AC or DC circuit. Appropriate color-coding shall be utilized for all other field wiring.

D. All electrical circuits shall be numerically tagged with suitable markings at each terminal point. All circuits shall correspond with the installation draw.

3.3 ROUTINE MAINTENANCE

A. Routine maintenance on equipment shall be performed as recommended by the manufacturer's installation, operation and maintenance manual. At a minimum, the routine maintenance will include the following by a certified SEVO Systems Distributor:

1. Visual Check of Pipe network and distribution nozzles per the operation and maintenance manual.
2. Weight and pressure of the SEVO Engineered System cylinders per the operation and maintenance manual.
3. Inspect all cylinders and equipment for damage per the operation and maintenance manual.
4. Routine maintenance on the suppression system shall be performed as recommended by NFPA 2001, current edition.

END OF SECTION 212200

SECTION 212201 – CLEAN-AGENT FIRE-EXTINGUISHING SYSTEM – 3M Novec

PART 1 - GENERAL

1.1 SUMMARY

A. This specification outlines the requirements for a “Total Flood + Extended Discharge” Clean Agent Fire Suppression System utilizing 3M™ Novec™ 1230 Fire Protection Fluid as the fire extinguishing agent. The work described in this specification includes all engineering, labor, materials, equipment, and services necessary, and required, to complete and test the suppression and detection system.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit manufacturer’s information for each type of product indicated.

B. Shop Drawings (SD):

1. Include plans, elevations, sections, and attachment details.
2. Include design calculations.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, manufacturer-required clearances, method of field assembly, components, and location and size of each field connection.
4. Include power, signal, and control wiring diagrams.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For clean-agent fire-extinguishing system to include in emergency, operation, and maintenance manuals.

B. As-Built Drawings:

1. Upon completion of the installation, the installing contractor shall provide accurate as-built information to the “system supplier” for updates to the system design documents which will in turn be updated and provided back to the installing contractor.

1.4 QUALITY ASSURANCE

A. Installer:

1. The system shall be designed by the system components supplier.
2. The installing contractor shall be trained by the supplier to install, test, and maintain a clean agent system.
3. When possible, the installing contractor shall employ a NICET certified special hazard designer, level 2 or above, who will be responsible for this project.
4. The installing contractor shall be an experienced firm regularly engaged in the installation of automatic clean agent, or similar, fire suppression systems in strict accordance with all applicable standards.
5. The installing contractor must have a minimum of five (5) years documented experience in the design, installation, and testing of clean agent, or similar, fire suppression systems. A list of systems of a similar nature and scope shall be provided on request.

1.5 MAINTENANCE

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

1. Detection Devices.
2. Container Valves.
3. Nozzles.
4. Extinguishing Agent.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. The system shall be a “Total Flood + Extended Discharge” Clean Agent Fire Suppression System utilizing 3M™ Novec™ 1230 Fire Protection Fluid as the fire extinguishing agent and meeting the standards listed in 1.2 above.

B. The Clean Agent Fire Suppression System shall provide a minimum design concentration by volume as determined by the “system supplier.”

C. The Clean Agent Fire Suppression System materials and equipment shall be standard products of the “system supplier's” design and suitable to perform the functions intended. When one or more pieces of equipment must perform the same function(s), they shall be duplicates and provided by the “system supplier.”

2.2 PIPE AND FITTINGS

A. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001. All items shall be in accordance with the “system supplier’s” requirements.

B. Steel Pipe: ASTM A53, Type S, Grade B or ASTM A106 Grade A and Grade B; Schedule 40, Schedule, 80, and Schedule 160, seamless steel pipe.

1. Threaded Fittings (NPS 2 and Smaller):

a. Malleable-Iron Fittings: ASME B16.3, Class 300.
b. Flanges and Flanged fittings: ASME B16.5, Class 300 unless otherwise indicated.
c. Working Pressure for Fittings shall meet minimum pressure requirements from system manufacturer.

2. Forged-Steel Welding Fittings (NPS 2-1/2 and Larger):

a. ASME B16.11, Class 3000, socket pattern.

2.3 AGENT STORAGE CONTAINERS

A. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gauge.

1. Manifold:

a. Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated by “system supplier”.

2. Storage Tank Brackets:

a. Factory or field fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling/replacement.

2.4 NOZZLES

A. Description: Equipment manufacturer’s standard one-piece brass or aluminum allow of type, size, discharge pattern, and capacity required for application.

1. Material shall be corrosion-resistant metal stamped with orifice size and type.

2.5 CONTROL PANEL

A. The Control Panel, and its components, shall be UL listed and FM approved for Clean Agent Releasing Service and be suitable for Deluge/Pre-action sprinkler service.

B. The Control Panel shall perform all functions necessary to operate the system detection, actuation, and auxiliary functions, as outlined.

C. The Control Panel shall support Cross Zoned, Sequential, Single Detector Release and Manual Release detection/actuation methods.

1. The Control System shall provide the following capabilities and functions:

a. Programmable pre-discharge and discharge timers
b. Resettable and continuous auxiliary output power
c. Four (4) optional Abort types

d. Intelligent Transistor protection to prevent noise spikes and microprocessor failure from inadvertently activating release outputs.
e. Dedicated alarm and trouble contacts programmable for alarm, trouble, pre-discharge, discharge, abort, supervisory or water flow functions, depending on panel configuration.

D. The Control Panel shall be specifically cross listed with the releasing solenoid of the Total Flooding+ Extended Discharge (contact the “system supplier” for further information solenoid compatibility).

2.6 DETECTION DEVICES

A. Devices shall be compliant with NFPA 2001, NFPA 72, and EL 268.

B. Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.

C. Photoelectric Detectors: LED light source and silicon photodiode receiving element.

D. Signals to Central Fire-Alarm Control Panel: Any type of local system trouble is reported to central fire-alarm control panel as a composite "trouble" signal. Alarms on each system zone are individually reported to central fire-alarm control panel as separately identified zones.

2.7 MANUAL STATIONS

A. FM Approved or NRTL listed, with clear plastic hinged cover, 120-V ac or low-voltage compatible with controls. Include contacts for connection to control panel.

B. Manual Release: "MANUAL RELEASE" caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.

C. Abort Switch: “ABORT” caption, momentary contact, with green finish.

2.8 ALARM DEVICES

A. FM Approved or NRTL listed, low voltage, and surface mounting.

B. Bells: Minimum 6-inch diameter.

C. Horns: 90 to 94 dBA.

D. Strobe: Translucent lens, with “FIRE” caption.

2.9 CAUTION AND ADVISORY SIGNS

A. Provide signs, as required, to comply with NFPA 2001 and the recommendations of the “system supplier”:

B. Entrance sign: One (1) required at each entrance into a protected space.

C. Manual Discharge Sign: One (1) required at each manual discharge station.

D. Abort Station Sign: One (1) required at each abort station.

E. Flashing Light sign: One (1) required at each agent discharge strobe over each exit from a protected space.

PART 3 - EXECUTION

3.1 SYSTEM INSTALLATION

A. Install clean-agent containers, piping, and other components level and plumb, in accordance with manufacturers' written instructions.

B. Clean-Agent Container Mounting:

1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

C. Install pipe and fittings, valves, and discharge nozzles in accordance with requirements listed in NFPA 2001, Section "Distribution."

1. Install valves designed to prevent entrapment of liquid or install pressure relief devices in valved sections of piping systems.
2. Support piping using supports and methods in accordance with NFPA 13.
3. Install seismic restraints for extinguishing-agent piping systems.
4. Install control panels, detection system components, alarms, and accessories, in accordance with requirements listed in NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

3.2 PIPING INSTALLATION

A. Distribution piping, and fittings, shall be installed in accordance with the “system supplier’s” requirements, NFPA 2001, and approved piping standards and guidelines. All distribution piping shall be installed by qualified individuals using good, accepted practices and quality procedures. All piping shall be adequately supported and anchored at all directional changes and nozzle locations.

1. All piping shall be reamed, blown clear and swabbed with suitable solvents to remove burrs, mill varnish and cutting oils before assembly.
2. All pipe threads shall be sealed with Teflon tape pipe sealant applied to the male thread only.

3.3 FIELD QUALITY CONTROL

A. After system installation has been completed, the entire system shall be checked out, inspected, and functionally tested by qualified, trained personnel, in accordance with the “system supplier’s” recommended procedures and NFPA standards.

B. All containers and distribution piping shall be checked for proper mounting and installation.

C. The complete system shall be functionally tested, in the presence of the “system supplier” or his representative, and all functions, including system and equipment interlocks, must be operational.

D. Acceptance Tests:

1. The tests shall demonstrate that the entire control system functions as designed and intended. All circuits shall be tested.
2. A room pressurization test shall be conducted to determine the presence of openings, which would affect the agent system design. The test(s) shall be conducted using the Retro-Tec Corp. Door Fan system, or equivalent, with integrated computer program. All testing shall be in accordance with “system supplier” requirements.
3. Upon acceptance by CAWCD, the completed system(s) shall be placed into service.

3.4 TRAINING REQUIREMENTS

A. Prior to final acceptance, the installing contractor shall provide operational training to CAWCD personnel.

3.5 INSPECTIONS INTERVALS

A. The system shall be regularly tested & inspected in accordance with NFPA 2001. The first inspection shall be at the six-month interval, and the second inspection at the 12-month interval, and thereafter semi- annually after system acceptance.

END OF SECTION 212201

SECTION 213000 - FIRE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vertical In-Line Pumps
2. Horizontal Base-Mounted Pumps
3. Vertical Turbine Pumps
4. Fire Pump Accessories
5. Electric Motor Drive
6. Pressure Maintenance (Jockey) Pump
7. Electrical Characteristics and Components

1.2 SYSTEM DESCRIPTION

A. Design:

1. Conform to NFPA 20.

B. Performance:

1. Conform to NFPA 20 and NFPA 25.

1.3 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit manufacturers literature including general assembly, pump curves showing performance characteristics with pump and system, operating point indicated, NPSH curve, controls, wiring diagrams, and service connections.

B. Shop Drawings (SD):

1. Include plans, elevations, sections, and mounting and attachment details.
2. Indicate layout, general assembly, components, dimensions, weights, clearances, and methods of assembly.
3. Include diagrams for power, signal, and control wiring.

C. General (G):

1. Manufacturer's Installation Instructions: Support details, connection requirements, for fire pump system.

D. Operation and Maintenance Data:

1. For fire pumps to include in operation and maintenance manuals.

E. Quality Control Reports (QCR)

1. Field Test Reports: Indicate results of hydrostatic test and field acceptance tests.
2. Manufacturer's Certificate: Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work according to UL Fire Protection Equipment Directory, FM Approval Guide or Intertek Testing Services (Warnock Hersey Listed) standards.

B. Design fire pump system under direct supervision of professional engineer experienced in design of this Work and licensed in State of Arizona.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1. Firms whose fire pumps, pressure maintenance pumps, drivers, controllers, and major accessories are listed by product name and manufacturer in UL “Fire Protection Equipment Directory” and comply with other requirements indicated. Pressure maintenance (jockey) pumps are exempt from UL listing requirement.
2. Provide listing/approval stamp, label, or other marking on equipment made to specified.
3. Factory Tests: Perform factory test of fire pump. Copy to be submitted to Engineer prior to shipment.

B. Installer: Company specializing in performing Work of this Section with minimum three years documented experience and approved by manufacturer.

1.6 DELIVERY, STORAGE AND HANDLING

A. Preparation for Shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anti-corrosion compound. Protect flanges, pipe openings, and nozzles.

B. Store fire pumps, pressure maintenance pumps, drivers, controllers, and accessories in a clean dry place.

C. Retain shipping flange protective covers and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. For extended storage greater than five (5) days, dry internal parts with hot air or a vacuum-producing device to avoid rusting internal parts. Upon drying, coat internal parts with a protective liquid, such as light oil. Dismantle bearings and couplings, dry and coat them with an acid-free heavy oil, and then tag and store in a dry location.

F. Comply with manufacturer’s rigging instructions for handling.

1.7 WARRANTY

A. Furnish five-year manufacturer warranty for fire pumps.

1.8 MAINTENANCE

A. Furnish one set of gaskets, screens and seals for each pump type and model supplied.

PART 2 - PRODUCTS

2.1 FIRE PUMPS

A. Manufacturers:

1. A-C Fire Pump; a Xylem brand
2. Patterson Pump Company; a Gorman-Rupp Company
3. Peerless Pump Company

2.2 VERTICAL IN-LINE PUMPS

A. Type: UL 448, vertical, single stage, close coupled, radial or horizontally split casing, for in-line mounting, for 250 psig.

B. Casting: Cast or ductile iron, with suction and discharge gage port, casing wear ring, seal flush connection, drain plug, and ASME B16.1 flanged suction and discharge.

C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft.

D. Shaft: Solid alloy steel with bronze sleeve.

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

F. Performance: Flow Rate and head as indicated on drawings.

2.3 HORIZONTAL BASE-MOUNTED PUMPS

A. Type: UL 448, horizontal shaft, single-stage, double-suction, direct-connected, horizontally split casing, for 250 psig maximum working pressure.

B. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, and ASME B16.1 flanged suction and discharge.

C. Impeller: Bronze double-suction fully enclosed, balanced and keyed to shaft.

D. Bearings: Grease lubricated ball bearings, replaceable without opening casing.

E. Shaft: Alloy steel with replaceable bronze shaft sleeve.

F. Seal: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 230 degrees F maximum continuous operating temperature.

G. Drive: Flexible coupling with coupling guard.

H. Base plate: Cast iron or fabricated steel with integral drain rim.

I. Performance: Flow Rate and head as indicated on drawings.

2.4 VERTICAL TURBINE PUMPS

A. Type: UL 448 vertical, centrifugal, turbine.

B. Casing: Cast iron, rated for 250 psig or 1.20 times actual discharge working pressure discharge gage, air vent, wear rings, seal flush connection, drain plug, and flanged discharge.

C. Impellers: Bronze, fully enclosed, keyed to shaft or secured with lock nut.

D. Shaft: Stainless steel with stainless steel sleeve through seal chamber.

E. Seals: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings.

F. Performance: Flow Rate and head as indicated on drawings.

2.5 FIRE PUMP ACCESSORIES

A. Eccentric suction reducer and OS&Y gate valve on suction side of pump.

B. Concentric increaser and check valve in pump discharge and butterfly valve on system side of check valve.

C. Fire pump bypass fitted with butterfly valves (as indicated on drawings) and check valve.

D. Circulation relief-valve: UL 1478, brass, spring loaded, and enclosed type waste cone.

E. Suction pressure gauge: Oil-Filled 4-1/2-inch diameter dial with snubber, valve cock and lever handle.

F. Oil filled discharge pressure gauge mounted on board attached to pump, with snubber, valve cock and lever handle.

G. Casing: 3/4-inch relief valve.

H. Float operated 3/4-inch automatic air release valve.

I. Ductile iron or brass body, hose valve test header manifold having nozzle outlets arranged in a single line, for horizontal flush wall mounting, polished chrome-plated rectangular brass escutcheon plate with lettering equivalent to "PUMP TEST CONNECTION.

J. Hose valve test header manifold and round brass identification escutcheon plate for wall mounting, manufacturer's standard finish, with lettering equivalent to "PUMP TEST CONNECTION".

K. 2-1/2-inch hose gate valves with caps and chains, NFPA 1963 hose thread conforming to Local Fire Department Standards, bronze finish.

L. Flow metering system for closed loop testing.

M. Ball drip valve.

N. Closed discharge cone.

O. Fire pump jacking bolts for use in precision alignment.

2.6 ELECTRIC MOTOR DRIVE

A. Motor: Squirrel cage induction type; in open drip-proof NEMA MG-1 enclosure.

B. Fire Pump Motor Nameplates: Provide nameplates, complete with motor horsepower, characteristics, and other pertinent data.

C. Fire Pump Motor Factory Finish: Red enamel paint, same as for fire pump, applied to assembled, tested units prior to shipping.

D. Pressure Maintenance Pump Electric Motors: NEMA MG 1, open drip-proof, squirrel cage, induction motor, complying with NFPA 20 fire pump motor requirements and NFPA 70, and wiring compatible with controller.

E. Pressure Maintenance Pump Motor Factory Finish: Enamel paint, same as for pressure maintenance pump, applied to assembled unit.

2.7 FIRE PUMP CONTROLLERS AND ALARM PANELS, GENERAL

A. Fire Pump Controllers and Alarm Panels: Combined automatic and non-automatic operation, UL listed, and FM approved, factory-assembled and wired, and factory-tested, of types, capacities, electrical characteristics, and with features indicated.

1. Standard: UL 508.
2. Manufacturer: Firetrol.

B. Enclosure: NEMA ICS 6, Type 3R, drip-proof, indoor, except where special-purpose enclosure is indicated.

C. Provide controls, devices, alarms, functions, and operations listed in NFPA 20, as required for the type of driver and controller used, and the specific items listed for each type controller.

D. Nameplates: Provide nameplate complete with capacity, electrical characteristics, approvals and listings, and other pertinent data, on enclosure door.

E. Provide mounting for enclosures as indicated:

1. Full-Service Fire Pump Controller Mounting: Wall or floor stand type, as indicated, for field electrical connections.
2. Alarm Panel Mounting: Wall type.
3. Factory Finish: Red enamel paint applied to assembled, tested units prior to shipping.

F. Controller Sensing Pipes: Provide nonferrous metal sensing piping, 1/2-inch size, with 1/2-inch globe valves for testing mechanism of controller, from system to pump controller, as indicated. Provide bronze check valve with 3/32-inch orifice in clapper or ground-face union with non-corrosive diaphragm having 3/32-inch orifice.

1. Fabricate pipe and fittings in accordance with NFPA 20.

2.8 FULL-SERVICE, ELECTRIC MOTOR DRIVE FIRE PUMP CONTROLLERS

A. Motor Controllers: Controller specifically listed for electric motor drive fire pump service and service entrance.

1. Type: Reduced Voltage/Soft Start (up to 700 locked rotor amps)

B. Rate Controller for scheduled horsepower: Provide controller with short circuit withstand rating at least equal to short circuit current available at controller location, taking into account cable size and distance from substation or supply transformers.

C. Automatic Transfer Switch: Enclosure complying with requirements for and attached to fire pump controller above, containing an automatic transfer switch having rating at least equal to the fire pump driver motor horsepower; or when motor is rated in amperes, shall have an ampere rating not less than 115 percent of the motor full-load current and also shall be suitable for switching the motor locked rotor current. Coordinate with Electrical Contractor.

1. The words "FIRE PUMP POWER TRANSFER SWITCH" must appear on the front of the panel and additionally carry a UL 1008 listing.

D. Voltage Surge Arrestor: Provide voltage surge arrestors complying with ANSI C62.1 or C62.11 installed from each line terminal of the isolating switch to ground. These devices shall be rated to suppress voltage surges above rated line voltage.

E. Provide controller capable of performing or containing the following features:

1. Isolating means and circuit breaker.
2. “Power On" pilot lamp.
3. Fire alarm system connections for indicating motor running condition, loss of line power, and line power phase reversal.
4. Automatic and manual operation, and minimum run time relay to prevent short cycling.
5. Water pressure actuated switch having independent high and low calibrated adjustments responsive to water pressure in Fire Protection System.
6. Manual and automatic shutdown.

7. Disconnect Switch: Externally operable, quick break type.
8. Circuit Breaker: Size to NFPA 20, minimum 65,000 amperes interrupting capacity.
9. Motor Starter: Energized automatically through pressure switch or manually by externally operable handle.
10. Pressure Switch: Set to cut in at 150 psig.
11. Running Period Timer: Keeps motor in operation when started automatically, for minimum of seven minutes.
12. Pilot Lamp: Indicates circuit breaker closed and power available.
13. Test Accessories: Ammeter test link and voltmeter test studs.
14. Alarm Relay: Energizes alarm to indicate circuit breaker open or power failure.
15. Switch Relay: For remote start.
16. Manual Selector Station: On enclosure marked "AUTOMATIC" and "NON-AUTOMATIC."

2.9 ALARM PANEL

A. Alarm Panel: NEMA ICS 6, Type 1 remote wall-mounting-type panel with audible and visible alarms matching type used by controller. Provide following features and manufacturer's standard features.

1. Electric Motor Drive Fire Pump Controller Alarm Panels:

a. Motor operating condition
b. Loss of line power
c. Phase reversal
d. Power On

2.10 PRESSURE MAINTENANCE (JOCKEY) PUMP

A. Manufacturers:

1. Armstrong Pumps, Inc.
2. Grundfos CBS Inc.
3. Patterson Pump Company.
4. Peerless Pump Company.
5. Substitutions: Substitution of specified jockey pump shall be approved by CAWCD prior to purchase and installation.

B. Pressure Maintenance Pumps, General: Base-mounted, factory-assembled, and factory-tested, of pump types, capacities, and electrical characteristics indicated. Close-coupled pressure maintenance pumps are exempt from base-mounted requirement.

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

D. Characteristics: Pressure maintenance pumps shall furnish not less than rated capacity at not less than total rated head indicated.

E. Construction: Cast iron pump casing with suction and discharge connections of size indicated, threaded, or flanged and machined to ANSI B16.1 dimensions, and 125 PSI minimum pressure rating, except where 250 PSI rated flanges are indicated.

1. Impeller: Bronze or stainless steel.
2. Shaft: Stainless steel.
3. Seals: Mechanical.

F. Nameplates: Provide nameplate complete with capacity, electrical characteristics, and other pertinent data.

G. Factory Finish: Manufacturer's standard color enamel paint applied to assembled, tested units prior to shipping.

H. Multi-Stage Pressure Maintenance Pumps:

1. Construction: Multi-stage, centrifugal, vertical construction, base mounting.

2.11 PRESSURE MAINTENANCE PUMP CONTROLLERS

A. Pressure Maintenance Pump Controllers: Combined automatic and non-automatic operation, UL listed, factory-assembled and wired, and factory-tested, of types, capacities, electrical characteristics, and with features indicated, for electric motor drive pressure maintenance pump service.

1. Type: Across the line.
2. Standard: UL 508.

B. Enclosure: NEMA ICS 6, Type 3R, wall mounted, for field electrical wiring.

C. Provide controls, devices, alarms, functions, and operations listed in NFPA 20, and the specific items listed.

D. Rate Controller for scheduled horsepower and provide the following items:

1. Fusible disconnect switch.
2. Pressure switch.
3. “HAND-OFF-AUTO” selector switch.
4. Pilot light.
5. Running period timer.

E. Nameplates: Provide nameplate complete with capacity, electrical characteristics, approvals and listings, and other pertinent data, on enclosure door.

F. Mounting: Wall-type for field electrical connections.

G. Controller Sensing Pipes: Provide non-ferrous metal sensing piping, 1/2-inch size, with 1/2-inch globe valves for testing mechanism of controller, from system to pump controller, as indicated. Provide bronze check valve with 3/32-inch orifice in clapper or ground-face union with non-corrosive diaphragm having 3/32-inch orifice.

1. Fabricate pipe and fittings in accordance with NFPA 20.

2.12 PRESSURE MAINTENANCE PUMP ACCESSORIES

A. Provide following accessory fittings, matching pressure maintenance pump suction and discharge ratings, as required for pump capacity rating:

1. Casing relief valve
2. Suction and discharge pressure gauges

2.13 FLOW MEASURING SYSTEMS

A. General: Fire pump flow measuring systems shall be FM approved, indicate flow in GPM to not less than 175 percent of fire pump rated capacity, and consist of a sensing element of size to match pipe, tubing, flow meter, and fittings.

B. Pressure Rating: 275 PSI minimum.

C. Provide flow measuring device, Gerand Engineering, Model K, calibrated venturi, fire pump test meter, or CAWCD approved equal.

D. Provide flow-measuring systems complete with operating instructions.

2.14 SOURCE QUALITY CONTROL

A. Factory Tests: Hydrostatically test and test-run each pump prior to shipment according to UL 448. Test at 150 percent of shut-off head plus suction head, but not less than 250 PSIG. Produce certified test curves showing head capacity and brake-horsepower of each pump.

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

C. Prepare test and inspection reports.

2.15 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: as indicated on drawings.

B. Disconnect Switch: Factory mounted on equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fire pump according to NFPA 20.

B. Install pumps with space for service access, no less than minimum recommended by manufacturer.

C. Install fire suppression piping according to Section 210500. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump independently

from pump casing. For base mounted pumps, install supports under elbows on pump suction and discharge.

D. Install drains for bases and seals. Install piping to and discharging into floor drains.

E. Provide fixed pipe support at pump suction and discharge so that piping weight is not transmitted to pump housing nozzles.

F. Set base-mounted pumps on steel I-beam. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.

1. Adjust the metal supports or wedges until the shafts of the pump and driver are level. Check the coupling faces and suction and discharge flanges of the pump to verify that they are level and plumb.

G. Connect to electrical service as shown on electrical drawings.

H. Lubricate pumps before startup.

I. Check, align, and certify base mounted pumps prior to start-up.

J. Install flow measuring system in accessible location.

3.2 ALIGNMENT

A. Align pump and driver shafts after complete unit has been leveled on foundation, and after grout has set and foundation bolts have been tightened.

B. After alignment is correct, tighten the foundation bolts evenly but not too firmly. Fill the base plate completely with non-shrink, non-metallic grout, with metal blocks and shims or wedges in place. After grout has hardened, fully tighten foundation bolts. Perform final alignment and take corrective measures required.

C. Make piping connections, check alignment, and take corrective measures required.

1. Adjust alignment of pump and driver shafts for angular and parallel alignment by one (1) of the two (2) methods specified in the Hydraulic Institute "Centrifugal Pumps - Instructions for Installation, Operation and Maintenance.
2. Alignment tolerances shall meet manufacturer's recommendations and ANSI/ASA S275-2017/Part 1 standards.

3.3 CONNECTIONS

A. General: Install valves of types and at locations indicated, that are same size as the piping connecting the fire pump, bypass, test header, and other piping systems.

B. Install suction and discharge pipe sizes equal to or greater than the diameter of fire pump nozzles.

C. Install pressure gauges on the suction and discharge of each pump at the integral pressure gauge tappings provided.

D. Install flow meters and sensing elements where indicated. Install connections, tubing, and fittings between flow sensing elements and meters as prescribed by manufacturer's installation instructions.

E. Electrical wiring and connections are specified in Division 26 sections.

3.4 IDENTIFICATION

A. Identify system components in accordance with requirements for fire-pump marking as indicated in NFPA 20 and in accordance with CAP specifications.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide the services of a factory-authorized service representative to supervise field assembly of components, installation of fire pump units and pressure maintenance pump units, including piping and electrical connections, field acceptance tests, and to report test results in writing.

B. Perform flow test on entire system according to NFPA 20.

C. Check suction lines connections for tightness to avoid drawing air into the pump.

D. Perform field acceptance tests of each fire pump unit (fire pump, driver, and controller) and system piping, when installation of fire pump units is complete. Comply with operating instructions and procedures of NFPA 20 to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as specified and as indicated, then retest to demonstrate compliance. Verify that each fire pump unit performs as specified and as indicated.

E. Schedule test to be witnessed by CAWCD.

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

G. Prepare test and inspection reports.

3.6 DEMONSTRATION AND TRAINING

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

B. Start-Up Services, General: Provide the services of a factory-authorized service representative to provide start-up service and to demonstrate and train CAWCD maintenance personnel as specified below.

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.
2. Train CAWCD maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

3. Review data in Operating and Maintenance Manuals.
4. Schedule training with at least seven (7) days advance notice.
5. Provide fire hoses in number, size, and of length as required to reach a storm drain or other acceptable location for the disposal of fire pump test water. These fire hoses are for use during field acceptance tests only and are not to become property of CAWCD.

C. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:

1. Lubricate oil-lubricated bearings.
2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.
3. Check electric motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
4. Check that pump is free to rotate by hand. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.

D. Starting Procedure for Pumps:

1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.
2. Open the sealing liquid supply valve if the pump is so fitted.
3. Start Motor.
4. Open the discharge valve slowly.
5. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.
6. Check the general mechanical operation of the pump and motor.
7. Check vibration levels on pump and motor inboard and outboard bearings. Vibration levels shall meet ISO 10816-7 and ISO 20816-3 standards.

END OF SECTION 213000

SECTION 220500 – COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SCOPE

A. Provisions of this section apply to all work specified in all sections under Division 22.

B. In addition, work in Division 22 is governed by the provisions of the Bidding Requirements, Contract Forms, General Conditions, and all sections under Division 01, General Requirements.

1.2 DEFINITIONS

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

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

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

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

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

1.3 EXAMINATION OF PREMISES

A. Contractor shall field verify measurements and existing conditions prior to bidding the project. Any conflicts discovered by the contractor during pre-bid process which may affect the scope or cost shall be reported to CAWCD. The submission of a bid shall indicate contractor completely understands these contract documents and the existing conditions. Pay all costs necessary to perform pre-bid existing conditions verification.

B. Determine in advance, the methods of installing and connecting the piping, equipment, fixtures, specialties, etc. and become thoroughly familiar with all of the requirements of this contract.

1.4 PLUMBING CONTRACTOR

A. The Plumbing Contractor shall be licensed and hold a current contracting license that has been valid for a minimum of five years in the State of Arizona as a plumbing contractor.

1.5 REGULATIONS, PERMITS, FEES, CHARGES, INSPECTIONS

A. Regulations: Comply with all applicable codes, rules, and regulations.

B. Inspections: All work must be inspected and approved by CAWCD.

1.6 FIELD CONDITIONS, DRAWINGS, AND SPECIFICATIONS

A. Refer to Division 01 for additional information on submittals and shop drawings.

B. Check all information and report any discrepancies before beginning work. If a conflict exists between the drawings and specifications, or between field conditions and the drawings and specifications, promptly notify CAWCD. Contractor to report discrepancies to CAWCD in time to avoid unnecessary work.

1.7 SUBMITTALS

A. General:

1. Comply with the requirements of Section 013300, Submittal Procedures, and the additional requirements specified herein.

B. Shop Drawings:

1. The contract drawings indicate the general layout of the piping and various items of equipment. Coordination with other trades and with field conditions is required. For this purpose, submit shop drawings of all installations not detailed on the contract drawings.
2. Shop drawings shall be new drawings prepared by the Contractor. Shop drawings shall identify the related contract drawing number or related reference drawing. Shop drawings shall be fully dimensioned, including both plan and elevation dimensions.
3. Submit shop drawings for review by CAWCD as required by the contract documents. Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field, or when there is a question as to whether contract documents are being complied with or the design intent is being met.

C. Product Data:

1. Submit product data for review on all scheduled pieces of equipment, equipment requiring electrical connections or connections by other trades, and as required by the contract documents. Include manufacturer's detailed shop drawings, specifications, and data sheets. Data sheets shall include capacities, RPM, BHP,

pressure drop, design and operating pressures, temperatures, and similar data. Manufacturer's abbreviations or codes are not acceptable.
2. List the name of the motor manufacturer and service factor for each piece of equipment.
3. Indicate equipment operating weights including bases and weight distribution at support points.

D. Operation and Maintenance Data:

1. Submit operation and maintenance data for review on all scheduled pieces of equipment, and as required by the contract documents.

E. Commissioning Documentation:

1. Submit commissioning plans, schedules, and related documentation in accordance with the contract documents.
2.

1.8 QUALITY ASSURANCE

A. Materials and equipment shall be new. Work shall be of good quality, free of faults and defects.

B. All equipment shall fit in the space provided.

C. Systems shall be built and installed to deliver their full rated capacity at the efficiency for which they were designed.

D. The entire plumbing system shall operate at full capacity without objectionable noise or vibration.

E. Materials and Equipment:

1. Each piece of equipment provided shall meet all detailed requirements of the drawings and specifications and shall be suitable for the installation.
2. Where two or more units of the same class of equipment are provided, use products of the same manufacturer; component parts of the entire system need not be products of the same manufacturer.

F. Work and Work Quality:

1. Work performed shall be of a quality that is acceptable to CAWCD and is equal to the standards of the trades. Contractor must staff the project with sufficient skilled workforce, including a fully qualified construction superintendent, to complete the work in the time allotted. The superintendent must be qualified to supervise all the work in his/her work category.
2. Install all materials in a neat and professional manner.
3. Follow Manufacturer's installation directions. If there is a discrepancy with the contract documents, obtain clarification from Manufacturer and/or Engineer of Record and approval from CAWCD before starting work.

G. Cutting and Patching:

1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this division, including plastering, masonry work, concrete work, carpentry work, firestopping, and painting, shall be performed by skilled craftsmen of each respective trade in conformance with the appropriate division of work. Additional openings required in building construction shall be made by drilling or cutting.
2. Fill holes which are cut oversize so that a tight fit is obtained around the objects passing through.
3. Do not core existing floors, walls, beams, or columns without permission of CAWCD, and then only as directed by a CAWCD approved CORE PERMIT.
4. New or existing work that is cut or damaged shall be restored to its original condition. Where alterations disturb existing finishes, the surfaces shall be repaired, refinished, and left in condition existing prior to commencement of work.

1.9 MATERIAL SAFETY DATA SHEETS

1. Refer to Section 019150 Section 1.6.

1.10 DELIVERY, STORAGE, AND HANDLING

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

B. Protect stored pipes, tubes, valves, and equipment covered in Division 22 from damage during storage:

1. Protect from moisture and dirt.
2. Elevate above grade.
3. Support all piping to prevent sagging and bending.
4. Do not store plastic pipes and piping specialties in direct sunlight if susceptible to UV damage.

C. If stored on-site, coordinate storage lay-down area with CAWCD.

1.11 APPROVALS OF MATERIALS AND EQUIPMENT

A. Refer to Division 01 for description of material and equipment for prior approvals and substitutions.

1.12 COOPERATIVE WORK

A. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration. See Division 01 for additional requirements.

B. Cooperative Work Includes:

1. General supervision and responsibility for proper location, rough-in and size of work related to Division 22 but provided under other divisions of these specifications.
2. Installation of sleeves, inserts and anchors bolts for work under sections in Division 22.

1.13 EXISTING MATERIALS AND EQUIPMENT

A. Disposition: With the exception of items that are to be reused or retained by CAWCD, all other materials indicated to be removed shall be removed and disposed of by the Contractor. Items that are indicated to be retained or returned to CAWCD shall be delivered to a storage area designated by CAWCD.

B. Unused Materials: All unused piping, controls and miscellaneous materials shall be removed by the Contractor except where located within walls, below or above existing construction which is not being altered and would require removal and replacement of this existing construction. All visible piping, etc., shall be removed and sealed or capped within wall, or below floor unless noted otherwise.

C. Exterior Services: The Contractor shall be responsible for maintaining plumbing services to the existing building during the construction period. Existing services are to be retained until such a time that the new services, if any, are completely installed and ready for use. Scheduling of service interruptions is to be coordinated with CAWCD 14 days in advance.

D. Disconnect, demolish, and remove plumbing systems, equipment, and components that are indicated to be removed.

1. Piping to be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material. Patch insulation, as required, to match adjacent areas.
2. Piping to be Abandoned In Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment and Fixtures to be Removed: Disconnect and cap services and remove equipment and fixtures.

E. Continuity of Services in Existing Building: Contractor shall permanently reroute existing plumbing services or provide temporary connection as required to maintain service to existing fixtures in building which are to remain in service.

F. Rerouting and Relocation of Existing Plumbing Equipment and Services in Existing Building:

1. General: Contractor shall reroute and relocate all existing materials which are in conflict with the building alterations, and which are required to be maintained in use.
2. Existing Piping: Where applicable, existing material may be reused in their original location unless otherwise indicated.

G. Testing: All existing services affected by the new construction, and which are to remain in operation shall be returned to their original condition. The existing services shall be

tested as new, as described in other sections of these specifications. If for any reason these requirements cannot be met, the Contractor shall immediately notify CAWCD.

1.14 CONSTRUCTION FACILITIES

A. General: Under this division of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to CAWCD's establishment and such facilities shall be kept clear of materials or equipment. Refer to Division 01 for additional requirements.

B. Furnish and maintain from the beginning to the completion of all work all lawful and necessary guards, railings, fences, canopies, lights, and warning signs. Take all necessary precautions required by city and state laws to avoid injury or damage to all persons and property.

1.15 ELECTRICAL WORK

A. Electrical wiring, including power wiring and control wiring, except as otherwise specified under Division 22, all raceways, outlet and junction boxes, and labor for installation of the wiring and equipment shall be included in Division 26 of the specifications.

B. Contractor shall be responsible for the checking and testing of all controls and the interlocks for a complete and satisfactory operating system.

C. Before ordering any motors and equipment, verify the available voltage and phase for all motors with the Division 26 Contractor.

D. Submit a complete list of all motors prior to final closeout of job indicating the location, horsepower, voltage, phase, and amperage draw of each motor.

E. All field wiring and equipment must conform to the applicable Division 26 specification sections.

PART 2 - PRODUCTS

2.1 EQUIPMENT DESIGN AND INSTALLATION

A. Design: Design all equipment in accordance with latest edition of ASME, AGA, UL and other applicable technical standards as follows:

1. Pressure Vessels: ASME Code constructed and stamped.
2. Electric Appliances: UL labeled.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Plumbing Accessibility/Clearance Checklist per 3.5-E.

3.2 VERIFICATION OF DIMENSIONS

A. Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions at site, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.

B. Drawings are essentially diagrammatic, and many offsets, elbows/bends, special fittings and exact locations are not indicated. Carefully study drawings and premises to determine best methods, exact locations, routes, building obstructions, and install apparatus and equipment in available locations. Install apparatus and equipment in manner and in locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.

3.3 CUTTING AND PATCHING

A. Cut work and patch per Division 01 as necessary to properly install the new work. As the work progresses, coordinate necessary openings, holes, chases, etc., in their correct location. If the required openings, holes, and chases are not in their correct locations, make the necessary corrections at no cost to CAWCD. Avoid excessive cutting and do not cut structural members without the consent of CAWCD. Include as a part of the work all structural framing required by penetrations through the roof and necessary steel to support ducts and pipes between structural steel unless shown on the structural drawings.

3.4 CLOSING-IN OF UNFINISHED WORK

A. Cover no work until inspected, tested, and approved. Where work is covered before inspection and test, uncover it, and when inspected, tested, and approved, restore all work to original proper condition.

3.5 ACCESSIBILITY

A. Install valves, thermometers, gauges, traps, cleanouts, control devices or other specialties requiring reading, adjustment, inspection, repairs, removal, or replacement conveniently and accessibly throughout the finished building. Where any of these devices are shown on the contract drawings to be installed above any inaccessible ceiling or behind any inaccessible wall, the Plumbing Contractor shall furnish access doors or panels as required.

B. All access doors or panels in walls and ceilings required for access to control devices, traps, valves, and similar devices are to be furnished and installed as part of the work under this section. Provide type as detailed in project drawings.

C. Refer to architectural drawings for type of wall and ceiling in each area and for rated construction.

D. Coordinate work of various sections to locate valves, traps, etc. with others to avoid unnecessary duplication of access doors.

E. The Contractor, along with CAWCD's construction inspector, shall complete the Plumbing Accessibility/Clearance Checklist at the end of this section for all plumbing equipment. The chart shall be submitted to CAWCD for approval prior to substantial completion. All conflicts shall be resolved to the CAWCD's satisfaction prior to submission.

3.6 ROOF FLASHINGS

A. Flash and counter flash all piping penetrating roofing membrane with flashing per roofing manufacturer's recommendations. Refer to architectural drawings for detailing of pipe penetrations through roof. Coordinate all roof penetrations with CAWCD prior to any work to verify roof is not currently warrantied by another contractor.

3.7 PRODUCT AND EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. All equipment, valves, sensors, etc., shall be installed in strict conformance with the manufacturer's recommendations and all codes.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

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

D. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.

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

F. Do not install any equipment in an application not recommended by the manufacturer.

G. When joining dissimilar metals, provide dielectric fittings to prevent galvanic corrosion.

3.8 EQUIPMENT ROUGH-IN

A. Rough in all equipment and fixtures as designated on the drawings and in the specifications. The drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large-scale certified drawings. The Contractor shall obtain all certified rough-in information before progressing with any work for rough-in final connections.

B. Be responsible for providing all outlets and services of proper size at the required locations.

C. Minor changes in the contract drawings shall be anticipated and provided for under this contract.

1. Rough-in only (unless otherwise designated on the drawings) shall include providing all services as indicated and required, including all piping and valves. Valve and cap all piping stub-outs.

3.9 EQUIPMENT FINAL CONNECTIONS

A. Provide all piping final connections for all equipment under Division 22 and as indicated on the drawings.

3.10 EQUIPMENT SUPPORTS

A. Where supports, foundations, stands, suspended platforms for machinery, tanks, or other equipment are indicated or specified, perform the following:

1. Locate support members to avoid equipment strains and interference with piping connections and maintenance operations.
2. Where saddles are required, use cast iron or welded steel saddles with curvature to fit the tank shell.
3. Mount power-driven equipment on common base with driver.

B. Concrete Inserts: Furnish and install all concrete inserts required for all materials and equipment specified and/or shown on the drawings for Division 22.

3.11 CLEANUP

A. In addition to cleanup specified under Division 01, thoroughly clean all parts of the equipment and fixtures. Where exposed parts are to be painted, thoroughly clean off any splattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.

B. Thoroughly flush and clean all water systems.

C. During the progress of the work, keep the premises clean and free of debris.

3.12 PAINTING

A. Except as otherwise specified or indicated in the architectural drawings and/or specifications, paint all exposed unfinished metal with one coat of rust-inhibiting primer. Factory painted equipment shall be considered as having primed surface.

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

C. Finished painting is specified under Division 09.

3.13 CONNECTIONS TO SERVICES

A. Provide all connections to sanitary sewer lines, storm water lines, and water lines, except as otherwise specifically designated. Provide all necessary tees, taps and connections required to properly connect to all building services. Verify all requirements with civil drawings before making any piping connections to sanitary sewer, storm sewer, or water piping and conform to them during installation.

3.14 OBJECTIONABLE NOISE AND VIBRATION

A. Construct and brace piping systems to prevent vibration or rattling when systems are in operation. Install connections to equipment so noise and vibration will not reach the conditioned area through piping, conduit, or the building structure.

END OF SECTION 220500

PLUMBING ACCESSIBILTY / CLEARANCE CHECKLIST (SEE 3.5E)									
Building	Location	Unit #	Acceptable Access		Conflict	Date	Action	Observer	
			Yes	No				Owner	Contractor

SECTION 220503 – PLANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water Service Piping.
2. Drain and Vent Service Piping.
3. Oil Service Piping.
4. Compressed Air Service Piping.
5. Chlorine Service Piping.
6. Gage Service Tubing.
7. Solder Joints for Copper Service Piping.
8. Gaskets for Service Piping.
9. Dielectric Fittings and Couplings for Service Piping.
10. Link Type Seals for Service Piping.
11. Mastic and Tape.

1.2 DEFINITIONS

A. CWP: Cold Working Pressure.

B. DP: Design Pressure.

C. T: Service Temperature.

1.3 ACTION SUBMITTALS

A. Product Data (PD): Submit pipe materials and fittings; manufacturer's catalog information.

B. Shop Drawings (SD): Indicate layout of piping systems, including all equipment, critical dimensions, and sizes. Shop drawings are to include any existing conditions that may affect pipe routing.

C. General (G): Indicate pipe sizes and sizing methods. Indicate calculations used.

D. Quality Control Reports (QCR): Welders’ Certificate; Compliance with AWS B2.1. and Compliance with ASME Section IX.

1.4 QUALITY ASSURANCE

A. Perform Work according to:

1. ASME B31.3 code for installation of process piping systems.
2. ASME B31.1 code for installation of power piping.

3. ASME B31.5 code for installation of refrigerant piping systems.
4. ASME Section IX for welding materials and procedures.
5. ASTM B828 for qualification of soldering processes and procedures for copper and copper alloy pipe and tube.

B. Contractor:

1. Company specializing in performing Work of this Section with five years' experience.
2. All plumbers or fitters shall be skilled in their respective trade.

    a. Crew foreman for installer shall be licensed journeyman plumber or fitter through City of Phoenix Planning and Development Department or approved equal.
    b. A copy of the current license shall be available upon request.

C. Qualification of Welders:

1. All welders for work in this Section shall be certified welders. Certification shall be for the welding processes performed and shall have been received within the last five (5) years.
2. Upon request, the Contractor shall provide the names of welders employed in the work, together with certification that each of these welders has passed qualification tests as prescribed by the National Certified Pipe Welding Bureau, or by other reputable testing laboratory or agency in accordance with ANSI B31.1.3.

D. Manufacturer:

1. Company specializing in manufacturing products specified in this Section with three years' experience.
2. Manufacturer shall be ISO 9001 registered and assessed to ISO 9000 standard. A copy of the current certificate shall be available upon request.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS:

A. Piping and fittings connected to potable and domestic water systems shall be certified to NSF/ANSI 61 Annex G, and NSF/ANSI 372.

B. Piping Alternatives:

1. Provide piping in accordance with this Section, unless indicated on the Drawings or specified otherwise.
2. Alternative Pipe Ratings: Piping with greater pressure rating than specified may be substituted in lieu of specified piping without changes to the Contract Price. Piping of different material may not be substituted in lieu of specified piping.

2.2 WATER SERVICE PIPING:

A. Copper Piping, Water Service, CWP up to 150 psig:

1. Copper Tube:

    a. Drawn-Temper Copper Tubing: ASTM B88, Type K.
    b. Annealed-Temper Copper Tubing: ASTM B88, Type K.

2. Fittings:

    a. Solder Joint Fittings: ASME B16.18 cast copper, or ASME B16.22 wrought copper.
    b. Elbows 4" and smaller shall be long radius.
    c. Threaded ends shall conform to ASME B1.20.1.

3. Unions: For NPS 2" and smaller, ASME B16.22 wrought or ASME B16.18 cast, copper alloy body, hexagonal stock, metal-to-metal seating surfaces, and solder-joint ends.
4. Companion Flanges: For 2-1/2” and larger:

    a. Two-piece, Class 150, Flat-face type, drilled to ASME B16.5, solder-joint ends, ASTM B75 wrot copper solder cup, Powder coated steel flange, Nibco Model 672 or CAWCD approved equal.
    b. Single piece, Class 150, Flat-face type, drilled to ASME B16.5, solder-joint ends, ASTM B584 Cast Bronze Alloy. Nibco Model 771 or CAWCD approved equal.

B. Steel Piping for CWP up to 150 psig systems:

1. Steel Pipe: ASTM A53/A53M Type E or S, or ASTM A106, Schedule 40, galvanized.
2. Fittings:

    a. NPS 2" and smaller: ASME B16.3, ASTM A47/A47M malleable iron, threaded, class 150, galvanized.
    b. NPS 2-1/2" and larger: ASME B16.9 standard weight steel, butt welding, seamless.
    c. Elbows to be long radius unless otherwise noted.

3. Unions: NPS 2" and smaller: class 150, malleable iron, threaded, galvanized.
4. Flanges: NPS 2-1/2" and larger: ASME B16.5 forged steel, class 150, galvanized.

C. Steel Piping for CWP greater than 300 psig systems:

1. Steel Pipe: ASTM A53/A53M Type S, or ASTM A106, Schedule 80.

    a. Schedule 40 may be used in lieu of schedule 80 if Engineer of Record provides stress calculations as a submittal.

2. Fittings:

    a. NPS 2” and smaller: ASME B16.3, ASTM A47/A47M malleable iron, threaded, class 300, galvanized.

b. NPS 2-1/2" and larger: ASME B16.9 standard weight steel, butt welding, seamless, black.
c. Elbows to be long radius unless otherwise noted.

3. Unions: NPS 2" and smaller: Malleable Iron Union, class 300, malleable iron, threaded, black.
4. Flanges: NPS 2-1/2" and larger: Forged Steel Flange, ASME B16.5 forged steel, class 300, black.

D. PVC Piping, Chlorinated Water Supply Piping:

1. PVC Pipe: ASTM D1785, Schedule 80.
2. Fittings: ASTM D2467, Schedule 80, PVC.
3. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
4. For connections to equipment and valves with threaded connections, furnish solvent-weld socket to screwed joint adapters and unions, or ASTM D2464, Schedule 80, threaded, PVC pipe.

2.3 DRAIN AND VENT SERVICE PIPING

A. Copper Drain and Vent Piping:

1. Copper Tube:

a. Drawn-Temper DWV Copper Tubing: ASTM B306, Type DWV.
b. Drawn-Temper Copper Tubing: ASTM B88, Type K.

2. Fittings:
a. Solder Joint Fittings: ASME B16.18 cast copper, or ASME B16.22 wrought copper.
b. DWV drainage fittings with Solder Joints: ASME B16.29 wrought copper, or ASME B16.23 cast copper alloy.
c. Elbows 4" and smaller shall be long radius.
d. Threaded ends shall conform to ASME B1.20.1.

3. Unions: For NPS 2" and smaller, ASME B16.22 wrought or ASME B16.18 cast, copper alloy body, hexagonal stock, metal-to-metal seating surfaces, and solder-joint ends.
4. Companion Flanges: For 2-1/2” and larger:

a. Two-piece, Class 150, Flat-face type, drilled to ASME B16.5, solder-joint ends, ASTM B75 wrot copper solder cup, Powder coated steel flange, Nibco Model 672 or CAWCD approved equal.
b. Single piece, Class 150, Flat-face type, drilled to ASME B16.5, solder-joint ends, ASTM B584 Cast Bronze Alloy. Nibco Model 771 or CAWCD approved equal.

2.4 OIL SERVICE PIPING:

A. Steel Piping, CWP greater than 150 psig:

1. Steel Pipe: ASTM A53/A53M Type E or S, Schedule 80 black steel.
2. Fittings:

    a. NPS 2" and smaller: ASME B16.3, ASTM A47/A47M malleable iron, threaded, class 300.
    b. NPS 2-1/2" and larger: ASME B16.9 standard weight steel, butt welding, seamless.
    c. Unions: Class 300, malleable iron, threaded ends, black steel.
    d. Flanges: ASME B16.5, minimum Class 300, including bolts, nuts, and gaskets.

B. Steel Piping, CWP = 150 psig:

1. Steel Pipe: ASTM A53/A53M Type E or S, Schedule 40 black steel.
2. Fittings:

    a. NPS 2" and smaller: ASME B16.3, ASTM A47/A47M malleable iron, threaded, class 150.
    b. NPS 2-1/2" and larger: ASME B16.9 standard weight steel, butt welding, seamless.
    c. Unions: Class 150, malleable iron, threaded ends, black steel.
    d. Flanges: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets.

2.5 COMPRESSED AIR SERVICE PIPING:

A. Steel Piping, CWP up to 150 psig:

1. Steel Pipe: ASTM A53/A53M Type E or S, or ASTM A106, Schedule 40, black.
2. Fittings:
    a. NPS 2" and smaller: ASME B16.3, ASTM A47/A47M malleable iron, threaded, class 150.
    b. NPS 2-1/2" and larger: ASME B16.9 standard weight steel, butt welding, seamless.
    c. Elbows to be long radius unless otherwise noted.

3. Unions: NPS 2" and smaller: class 150, malleable iron, threaded, galvanized.
4. Flanges: NPS 2-1/2" and larger: ASME B16.5 forged steel, class 150, galvanized.

B. Copper Piping, CWP up to 150 psig:

1. Copper Tube:
    a. Drawn-Temper Copper Tubing: ASTM B88, Type K.
    b. Annealed-Temper Copper Tubing: ASTM B88, Type K.

2. Fittings:
    a. Solder Joint Fittings: ASME B16.18 cast copper, or ASME B16.22 wrought copper.
    b. Elbows 4" and smaller shall be long radius.
    c. Threaded ends shall conform to ASME B1.20.1.

3. Unions: For NPS 2" and smaller, ASME B16.22 wrought or ASME B16.18 cast, copper alloy body, hexagonal stock, metal-to-metal seating surfaces, and solder-joint ends.
4. Companion Flanges: For 2-1/2” and larger:

    a. Two-piece, Class 150, Flat-face type, drilled to ASME B16.5, solder-joint ends, ASTM B75 wrot copper solder cup, Powder coated steel flange, Nibco Model 672 or CAWCD approved equal.
    b. Single piece, Class 150, Flat-face type, drilled to ASME B16.5, solder-joint ends, ASTM B584 Cast Bronze Alloy. Nibco Model 771 or CAWCD approved equal.

C. Steel Piping, CWP greater than 300 psi:

1. Stainless Steel Pipe: (NPS 1” and smaller): ASME SA213 TP316 seamless, cold drawn stainless steel, minimum schedule 80. TP316L and TP316N stainless steel is not acceptable.

    a. 1-inch O.D. x 0.134-inch average wall.
    b. 3/4-inch O.D. x 0.109-inch average wall
    c. 1/2-inch O.D. x 0.065-inch average wall.
    d. 3/8-inch O.D. x 0.049-inch average wall.
    e. 1/4-inch O.D. x 0.035-inch average wall.

2. Steel Pipe: (NPS 1-1/4” and larger): ASME SA106B seamless pipe of appropriate diameter and schedule.
3. Fittings:

    a. ASME B16.9 standard weight steel, butt welding, seamless.
    b. Elbows to be long radius unless otherwise noted.

4. Flanges: ASME B16.5 forged steel, class 900, galvanized.

2.6 CHLORINE SERVICE PIPING:

A. Dry chlorine service (Metallic Piping):

1. ASTM A-106 Gr. B, schedule 80 seamless carbon steel piping shall be used (temperature range from -20°F to 300°F).
2. Threaded or socket welded construction shall be used for pipe diameters of 1-1/2 inch and less. Butt-welded and flanged joints shall be used for 2 inch and larger.

2.7 GAGE SERVICE TUBING:

A. Copper Tube, DP up to 300 psig:

1. Soft Copper Tube: Annealed-Temper Copper Tubing: ASTM B88, Type K.
2. Fittings: SAE J514/1 brass flared tube, or equivalent.

B. Stainless Steel Tube, DP greater than 300 psig:

1. Tubing: Stainless Steel Tubing: ASTM A269, seamless, annealed, Type 304 or 316.
2. Fittings: Stainless Steel (316), ASTM A276 bar stock, or ASTM A182 forgings

2.8 JOINTS FOR COPPER SERVICE PIPING:

A. Solder Joints (NPS 2 and smaller):

1. Flux: ASTM B813, Liquid or Paste type, water flushable.
2. Solder: ASTM B32, Alloy Grade Sn95 tin-silver, lead-free solder Stay-Brite ® 8 no substitutions.

B. Brazed Joints (NPS 2-1/2 and larger):

1. Brazing alloys shall have melting points above 1000 F, (ASME B31.2; NFPA 31, 51, 58).
2. Silver brazing alloy shall be AWS A5.8 classification BCUP-5, containing 15 percent silver, 80 percent copper, and 5 percent phosphorous.
3. Flux: AWS Standard A5.21, Type FB3-A or FB3-C.
4. Pipe and fittings charred or collapsed due to excessive heating will not be permitted and shall be removed from the job site.

2.9 BOLTS FOR FLANGED JOINTS AND FLANGED VALVES AND FLANGE INSULATION KITS

A. Unless otherwise specified, use American Standard, UNC threaded fasteners.

B. All Cast or Ductile Iron Flanges shall be installed with Heavy Hex Bolts and Nuts for 1/2” and larger bolts.

C. Carbon steel nuts shall not be used with stainless bolts and vice versa. Likewise, carbon steel washers shall not be used with stainless steel bolts or nuts and vice versa.

D. B-1 Flange Bolts: Carbon Steel, Cast Iron, or Ductile Iron Flanges, Class 150 (Pipe less than 20 inch)

1. Bolts (CAWCD preferred) or studs ASTM A307 Grade A
2. Nuts ASTM A563A or SAE J995 Grade 2
3. Washers ASTM F436
4. All fasteners shall be Zinc Plated ASTM F1941
5. If desired, A307 bolts and A563A nuts may be substituted with A194 bolts and F436 nuts per 2.9.D.

E. B-2 Flange Bolts: Carbon Steel, Cast Iron, or Ductile Iron Flanges, Class 300 (all sizes) and Class 150 (Pipe greater than 20 inch)

1. Bolts (CAWCD preferred) or studs ASTM A193 Grade B7, Heavy Hex
2. Nuts ASTM A194 Grade 2H, Heavy Hex
3. Washers ASTM F436, Zinc Plating ASTM F1941.
4. Finish:

a. Zinc Plating ASTM F1941 for bolts and nuts smaller than 1.0".
b. Plain Finish acceptable bolts and nuts 1.0" and larger. Bolts 1.0" and larger shall be protected by plastic "thread saver" wrap around mesh packaging in transit. Left over carbon from heat treatment shall be cleaned off the bolts prior to installation. Exposed exterior surfaces of bolt and nuts shall be painted with same exterior paint as valves and flanges after installation.

F. B-3 Flange Bolts: Cast Bronze and Stainless-Steel Flanges

1. Do not use zinc plated alloy steel fasteners directly with Bronze or Stainless-Steel Flanges. When joining stainless steel or cast bronze flanges use:
2. Bolts (CAWCD preferred) or studs ASTM A193 Grade B8 or B8M, Heavy Hex
3. Nuts ASTM A194 Grade 8 or 8M, Heavy Hex
4. SS304 or SS316 Washers
5. Utilize chloride free thread lubricant when assembling stainless steel bolts and nuts. Submit SDS for thread lubricant for CAWCD approval before use.
6. When a Stainless Steel or Cast Bronze flange is used with a Carbon Steel, Cast Iron, or Ductile Iron Flange at a joint, a flange insulation kit must be used.

2.10 GASKETS FOR SERVICE PIPING

A. Gasket dimensions and materials shall conform to ASME B16.21.

B. Segmented Gaskets shall not be allowed, unless otherwise approved by CAWCD.

C. Thickness: Minimum 3/32-inch thick for less than 1-inch pipe; minimum 1/8-inch thick for 10-inch and larger pipe.

D. G-1 Gasket: Plant Water Systems, high pressure water lines, large diameter flanges, and hydrocarbon service

1. Application(s):

a. Primary: Plant Water Systems (Raw Water, Unit Cooling), high pressure water systems (equal to or greater than 150 psig), and large diameter flanges (24-inch nominal and greater).
b. Secondary: Unit lubricating oil system, hydraulic oil systems, fuel oil and gasoline.

2. Aramid Fiber w/ Neoprene Binder.
3. Manufacturers and style:

a. Garlock, Blue-Gard, Style 3000
b. Or CAWCD approved equal

E. G-2 Gasket: General Plant Piping Use

1. Applications(s):

a. Primary: Water and air systems, less than 150 psig

2. Styrene-butadiene (SBR), 10.8 oz Cotton Insert, 80 Durometer

3. Manufacturers and style:

    a. Garlock, Style 19
    b. Or CAWCD approved equal

F. G-3 Gasket: Potable Water Systems

1. Applications(s):

    a. Primary: Potable Water Systems requiring NSF 61 materials.

2. Material(s):

    a. Synthetic Fiber Reinforced (non-asbestos) w/ or Proprietary Rubber Binder
    b. Fluoroelastomers (FKM)
    c. PTFE w/ Aluminosilicate Microspheres
    d. Ethylene Propylene Diene Monomer (EPDM), Synthetic Rubber Sheet

3. Manufacturers and style:

    a. Garlock, Multi-swell, Style 3760 (Proprietary Rubber)
    b. Garlock, Stress Saver XP (FKM)
    c. Garlock, Gylon 3504 or 3505 Stress Saver (PTFE)
    d. Garlock, Style 98206 (EPDM Rubber)
    e. Or CAWCD approved equal

2.11 DIELECTRIC FITTINGS AND COUPLINGS FOR SERVICE PIPING:

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

B. Dielectric Unions:

1. Manufacturers:
    a. A.Y. McDonald Mfg. Co.
    b. Capitol Manufacturing Company.
    c. Hart Industries International, Inc.
    d. Watts Regulator Co.
    e. Zurn Industries, LLC.
2. Description:
    a. Standard: ASSE 1079.
    b. Pressure Rating: Up to 150 psig. Do not use dielectric unions above 150 psig.
    c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers:
    a. NIBCO Inc.
    b. Capitol Manufacturing Company.
    c. Watts Regulator Co.
    d. Zurn Industries, LLC.

2. Description:
   a. Standard: ASSE 1079.
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Pressure Rating: 150 psig minimum or greater as required.
   d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. GPT Industries.
   d. Or CAWCD Approved Equal

2. When a dielectric flange isolating gasket kit is required, utilize double insulating kits unless approved otherwise by CAWCD.
3. Kit shall include:

   a. One phenolic (G10) gasket (Type E – full face gasket).
   b. Two G10 isolating washers for each bolt.
   c. One G10 or mylar isolating sleeve for each bolt.
   d. Two steel backing washers for each bolt.

4. Bolts and nuts used with flange insulation kits should utilize A193 grade B7 bolts, A194 Grade 2H nuts, and steel back-up washers supplied with dielectric-flange insulating kit unless approved otherwise by CAWCD.

E. Dielectric Nipples:

1. Manufacturers
   a. Anvil; an ASC Engineered Solution (Fig. 7088, 7089, 7090).
   b. Precision Plumbing Products, Inc.
2. Description:
   a. Standard: IAPMO PS 66.
   b. Electroplated steel nipple, complying with ASTM F 492.
   c. Pressure Rating: 300 psig at 225 deg F.
   d. End Connections: Male threaded or grooved.
   e. Lining: Inert and noncorrosive, polypropylene.

2.12 LINK TYPE SEALS FOR SERVICE PIPING:

A. Manufacturers:

1. Calpico, Inc.
2. Thunderline Corporation, Link-Seal.

B. Characteristics:

1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
2. Assemble links solely with stainless steel bolts and nuts to form a continuous rubber belt around the pipe.
3. Provide a stainless steel or glass reinforced nylon pressure plate under each bolt head and nut. Isolate pressure plate from contact with wall sleeve.

2.13 MASTIC AND TAPE:

A. Mastic and tape shall be compatible in all respects.

B. Mastic shall be Protecto-Wrap Co. "JS-160 Mastic," Tapecoat Co. "TCMastic," or equal.

C. Pipeline tape shall have 6-mil (0.15-mm) polyethylene backing and approximately 0.030 inch (0.8 mm) of butyl-base mastic adhesive.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Install piping in straight runs parallel to the axes of structures, plumb and level, unless directed otherwise by contract documents and Drawings.

B. Install drain piping:
1. Establish invert elevations, slope per table 704.1 of the 2018 International Plumbing Code (one percent minimum) in the direction of flow. Maintain gradients.
2. Slope piping and arrange systems to drain at low points.

C. Install automatic air vents at high point in piping systems that cannot be evaluated by other means and route vent to drain when required by project drawings.

D. Group piping whenever practical at common elevations.

E. Install exposed piping after installing equipment and after fitting locations have been determined.
1. Support piping so that there is no transfer of pipe loads and strain to equipment.

a. Pump suction and discharge piping shall be rigidly supported within 18 inches of the pump nozzles to prevent piping loads from being transmitted to the pump housing. Pipe support shop drawings at pump suction and discharge nozzles shall be approved by CAWCD prior to installation.

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

F. Assemble piping without distortion or stress caused by misalignment.
   1. Match and properly orient flanges, unions, flexible couplings, and other connections.
      a. For flanged joints, where one of the joining flanges is raised face type, provide a matching raised face type flange for the other joining flange.
   2. Do not subject piping to bending or other undue stresses when fitting piping. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
   3. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
   4. Alter piping assembly to fit when proper fit is not obtained.
   5. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

G. Sleeve pipe passing through partitions, walls, and floors. Refer to article 3.5.

H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

I. Provide access where valves and fittings are not accessible.

J. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means, which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.

K. New and existing flanged joints and valves, within scope of work, assembly requirements:

   1. New flanges and valves shall always be installed with all new bolts or studs, nuts, and gaskets.
   2. Existing flanges or valves that are removed from pipelines for work and re-used or re-assembled as a part of the project shall be cleaned by Contractor, and re-assembled with all new bolts or studs, nuts, and gaskets, unless otherwise approved by CAWCD.

L. Install non-conducting dielectric connections wherever joining dissimilar metals.

M. Install bell-and-spigot pipe with bell end upstream.

N. Protect piping systems from entry of foreign materials by temporary covers, completing sections of Work, and isolating parts of completed system.

O. Install piping penetrating roofed areas to maintain integrity of roof assembly.

P. Insulate piping as required and directed on the drawings.

3.3 COPPER JOINT CONSTRUCTION

A. Solder joint construction and requirements:

1. Ream ends of pipes and tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
3. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

B. Brazed joint construction and requirements:

1. Ream ends of pipes and tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
3. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," “Brazed Joints” chapter.

3.4 Protect piping systems from entry of foreign materials by temporary covers, completing sections of Work, and isolating parts of completed system.

A. Install piping penetrating roofed areas to maintain integrity of roof assembly.

B. Install valves according to Section 220523.

C. Insulate piping as required and directed by drawings.

D. Install pipe identification according to Section 220553.

3.5 WALL AND SLAB PENETRATIONS

A. On existing concrete construction, make holes for new piping with power-driven circular cutters. No pipe sleeves are required.

B. On new construction, provide pipe sleeves where piping passes through floors, walls, or ceilings. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, pilasters, columns, piers, and beams unless specified or otherwise indicated on the Drawings.

C. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping.

1. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
2. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
3. Seal spaces between pipes and sleeves with link-type seals for all water piping size 2 inches and above.

D. Cast couplings or wall pieces in walls for penetrations of buried rigid piping including cast iron, ductile iron, and reinforced concrete, through structures.

1. Provide couplings or wall pieces with mechanical push-ons, or similar flexible joints at outside faces of walls.
2. Provide additional similar joints in piping at transition points between trenches and structure excavations.
3. For steel piping, single joints may be used in lieu of 2 joints. Locate single joints outside within 2 feet from outside faces of walls. Link Seal: Use 2 link seals where seal is used to seal at wet wall sleeves. Mount one seal on the inside face of the wall and the other on the outside face of the wall. Coordinate the inside diameter of the wall sleeve with the size of the seal to provide watertight sealing.

3.6 INSTALLATION – COMPRESSED AIR PIPING SYSTEMS

A. Install compressed air piping systems piping according to ASME B31.3.

B. Install drip connections with valves at low points of piping system.

C. Install take-off to outlets from top of main, with shut off valve after take-off. Slope take-off piping to outlets.

D. Install compressed air couplings, female quick connectors, and pressure gauges as indicated on Drawings.

E. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.

F. Cut pipe and tubing accurately and install without springing or forcing.

G. Slope piping in direction of flow.

H. Install strainers on inlet side of pressure reducing valves.

3.7 FIELD QUALITY CONTROL

A. Service piping and tubing shall be tested in accordance with Section 345 of ASME B31.3, or as approved by CAWCD.

B. Perform the following tests and inspections:

C. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
    b. Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

3. Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Piping Tests for Water Service, Drain and Vent Service Piping:

1. Fill piping with water. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject water service piping to hydrostatic pressure of 1.5 X CWP, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Subject drain and vent piping to static water pressure equal to maximum expected service pressure. Isolate test source and allow it to stand for four hours. Leaks and loss in water level constitute defects that must be repaired.
6. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
7. Prepare reports for tests and for corrective action required.

E. Piping will be considered defective if it does not pass tests and inspections.

F. Test for Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping according to ASME B31.3.

3.8 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before use.
2. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.
3. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

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

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

3.9 PIPING SCHEDULE

A. Refer to the indicated drawing below for plant piping schedule:

1. Mark Wilmer Pumping Plant: MWP-M-D00998 (2 sheets)
2. Bouse Pumping Plant: BSH-M-D02411
3. Little Harquahala Pumping Plant: LHQ-M-D02511
4. Hassayamp Pumping Plant: HSY-M-D01790
5. Waddell Pump-Generating Plant: NWP-M-D14617 & NWP-M-D14618
6. Salt Gila Pumping Plant: SGL-M-D04464
7. Brady Pumping Plant: BRD-M-D10525 & BRD-M-D10583
8. Picacho Pumping Plant: PIC-M-D10460 & PIC-M-D10583
9. Red Rock Pumping Plant: RED-M-D10594 & RED-M-D10583
10. Twin Peaks Pumping Plant: TWP-M-D12976
11. Sandario Pumping Plant: SAN-M-D13036
12. Brawley Pumping Plant: BSP-M-D14256
13. San Xavier Pumping Plant: BSP-M-D14256
14. Snyder Hill Pumping Plant: SNY-M-D16068
15. Black Mountain Pumping Plant: BMT-M-D16128

END OF SECTION 220503

SECTION 220513 – Common Motor Requirements for Plumbing Equipment

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Single- and three-phase motors for application on equipment provided under other sections.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

B. Test Reports (TR):

1. Indicate procedures and results for specified factory and field testing and inspection.

C. Operations and Maintenance Data:

1. Include in final O&M Manuals provided to CAWCD.

1.3 QUALIFICATIONS

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

B. Testing Agency: Company shall be member of International Electrical Testing Association and specialize in testing products specified in this section with minimum three years documented experience.

C. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 220500 for Material Delivery and Storage.

B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.

D. For extended outdoor storage, remove motors from equipment and store separately.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate work under provisions of Division 01– General Conditions.

B. Coordinate installation of motors with other mechanical and electrical systems equipment being interfaced such as air handling units and motor control centers.

1.6 WARRANTY

A. Warranty services shall be provided by the contractor for two (2) years after final system acceptance in accordance with Division 01– General Conditions. These services shall consist of manufacturer's factory-trained representatives providing emergency repair service with on-site response within 24 hours of call, all test equipment and hardware necessary for maintenance and repair work and installation of modifications designed to improve system performance or eliminate known problems or deficiencies.

B. During the warranty period, provide new or revised documentation showing all changes required to solve system problems.

C. Submit written reports on each service or inspection to CAWCD during the warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Baldor

B. Dayton

C. General Electric

D. Reliance

E. U.S. Motors

F. Westinghouse

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service:

1. Motors 1/4 HP and smaller: 115 volts, single phase, 60 Hz.
2. Motors 3/4 HP and smaller, annual operating hours less than 3,000: 115 volts, single phase, 60 Hz.

3. Motors 1/2 HP and larger, annual operating hours greater than 3,000: 460 volts, three phase, 60 Hz.
4. Motors larger than 3/4 Horsepower: 460 volts, three phase, 60 Hz.

B. Type:

1. Single-phase motors shall be split phase, permanent split capacitor, capacitor start, or capacitor start/capacitor run type as determined by the application. Shaded pole motors are specifically prohibited.
2. Three-phase motors shall be open drip-proof or totally enclosed for indoor dry locations and shall be totally enclosed for outdoor or other wet locations.
3. Motors located in areas exposed to weather or wet conditions: Totally enclosed weatherproof epoxy-sealed type.
4. Design for continuous operation in 40ºC environment.
5. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

C. Visible Nameplate: Indicate manufacturer's name, model number, serial number, horsepower, voltage, phase, frequency, RPM, full load amps, locked rotor amps or code, frame size, service factor, power factor, nominal full-load efficiency, bearing sizes, insulation class, and rated ambient temperature.

D. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

E. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over-temperature protection.

2.3 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Less than seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Open Drip-proof Enclosure: Class B (80ºC temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve or ball bearings.

E. Enclosed Motors: Class B (80ºC temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

2.4 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Capable of exceeding one fourth of full load torque.

B. Starting Current: Less than six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class B (80ºC temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

2.5 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Capable of three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Open Drip-proof Enclosure: Class B (80ºC temperature rise) insulation, NEMA Service Factor (see table in Article 3.2), pre-lubricated ball bearings.

G. Enclosed Motors: Class B (80ºC temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

2.6 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Less than six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown and Pull-Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

E. Insulation: NEMA Class F or better.

F. Testing Procedure: In accordance with IEEE 112B. Load test motors to determine that they are free from electrical or mechanical defects in compliance with performance data.

G. Motor Frames: NEMA Standard Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Thermistor System (Motor Frame Sizes 284T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 262419 “Low Voltage Motor Control Centers”.

I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

J. Sound Power Levels: Motors shall conform to NEMA MG 1.

K. Part Winding Start where indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

L. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and stator surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

2.7 MOTOR EFFICIENCY

A. The manufacturer's nominal efficiency for the HP size specified shall be as shown in the Part 3 Schedules at 3/4 load and rated voltage when tested in accordance with IEEE 112B.

B. Motors 1/2 HP and smaller, with annual operating hours less than 3,000 may be the equipment manufacturer's standard and need not conform to these specifications.

2.8 MOTOR POWER FACTOR

A. The manufacturer's nominal power factor for the HP size specified shall be as shown in the Part 3 Schedules at 3/4 load and rated voltage when tested in accordance with IEEE 112B.

B. Motors 1/2 HP and smaller, with annual operating hours less than 3,000 may be the equipment manufacturer's standard and need not conform to these specifications.

2.9 SHAFT GROUNDING

A. All motors driven by a VFD shall include shaft grounding on the non-drive end of the motor. Shaft ground to be installed by electrical subcontractor. Shaft grounding kits to consist of brass or stainless steel brushes.

B. Manufacturer: Shaft Grounding Systems or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation.

C. Check line voltage and phase and ensure agreement with nameplate.

3.2 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.25
3/4	1.25	1.25	1.15	1.15
1-200	1.15	1.15	1.15	1.15

3.3 PERFORMANCE SCHEDULE: THREE PHASE - OPEN DRIP-PROOF

HP	Nominal RPM (Syn)	Power Frame	Minimum % NEMA 3/4 Load	Minimum % Efficiency Factor 3/4 Load
1	1200	145T	80.0	72.0
1-1/2	1200	182T	85.8	73.0
2	1200	184T	87.4	75.0
3	1200	213T	89.5	60.0
5	1200	215T	90.3	65.0
7-1/2	1200	254T	91.7	73.0
10	1200	256T	91.9	74.0
15	1200	284T	92.8	77.0
20	1200	286T	93.1	78.0
25	1200	324T	94.2	74.0
30	1200	326T	94.4	78.0
40	1200	364T	94.8	77.0
50	1200	365T	95.0	79.0
60	1200	404T	95.4	82.0
75	1200	405T	95.5	80.0

HP	Nominal RPM (Syn)	Power Frame	Minimum % NEMA 3/4 Load	Minimum % Efficiency Factor 3/4 Load
100	1200	444T	95.7	80.0
125	1200	445T	95.9	78.8
150	1200	445T	96.1	85.0
200	1200	447T	96.2	85.0
1	1800	143T	84.7	72.5
1-1/2	1800	145T	85.5	72.5
2	1800	145T	86.8	73.5
3	1800	182T	90.2	73.5
5	1800	184T	91.4	74.1
7-1/2	1800	213T	92.0	78.3
10	1800	215T	92.2	78.3
15	1800	256T	93.3	78.4
20	1800	256T	94.0	80.4
25	1800	284T	94.5	85.0
30	1800	286T	94.7	84.9
40	1800	324T	94.9	84.9
50	1800	326T	95.1	85.1
60	1800	364T	95.5	83.8
75	1800	365T	95.6	85.0
100	1800	404T	95.7	81.9
125	1800	405T	96.0	84.5
150	1800	444T	96.2	84.0
200	1800	445T	96.4	82.0
1	3600	143T	79.5	77.2
1-1/2	3600	143T	83.3	72.5
2	3600	145T	85.3	83.8
3	3600	145T	87.0	87.8

HP	Nominal RPM (Syn)	Power Frame	Minimum % NEMA 3/4 Load	Minimum % Efficiency Factor 3/4 Load
5	3600	182T	89.8	81.8
7-1/2	3600	184T	90.4	83.0
10	3600	213T	91.3	84.0
15	3600	215T	92.0	85.0
20	3600	254T	92.5	84.8
25	3600	256T	93.6	91.8
30	3600	284T	93.9	85.3
40	3600	286T	94.5	80.0
50	3600	324T	93.6	93.6
60	3600	326T	94.3	87.6
75	3600	364T	94.5	92.8
100	3600	365T	95.0	82.0
125	3600	404T	95.4	87.1
150	3600	405T	95.4	90.4
200	3600	444T	95.4	85.0

3.4 PERFORMANCE SCHEDULE: THREE-PHASE, TOTALLY ENCLOSED, FAN COOLED

HP	Nominal RPM (Syn)	Power Frame	Minimum % NEMA 3/4 Load	Minimum % Efficiency Factor 3/4 Load
1	1200	145T	80.0	72.0
1-1/2	1200	182T	85.8	73.0
2	1200	184T	87.4	75.0
3	1200	213T	89.5	60.0
5	1200	215T	90.3	65.0
7-1/2	1200	254T	91.7	73.0
10	1200	256T	91.9	74.0
15	1200	284T	92.8	77.0
20	1200	286T	93.1	78.0

HP	Nominal RPM (Syn)	Power Frame	Minimum % NEMA 3/4 Load	Minimum % Efficiency Factor 3/4 Load
25	1200	324T	94.2	74.0
30	1200	326T	94.4	78.0
40	1200	364T	94.8	77.0
50	1200	365T	95.0	79.0
60	1200	404T	95.4	82.0
75	1200	405T	95.5	80.0
100	1200	444T	95.7	80.0
125	1200	445T	95.9	78.8
150	1200	445T	96.1	85.0
200	1200	447T	96.2	85.0
1	1800	143T	84.7	72.5
1-1/2	1800	145T	85.5	72.5
2	1800	145T	86.8	73.5
3	1800	182T	90.2	73.5
5	1800	184T	91.4	74.1
7-1/2	1800	213T	92.0	78.3
10	1800	215T	92.2	78.3
15	1800	256T	93.3	78.4
20	1800	256T	94.0	80.4
25	1800	284T	94.5	85.0
30	1800	286T	94.7	84.9
40	1800	324T	94.9	84.9
50	1800	326T	95.1	85.1
60	1800	364T	95.5	83.8
75	1800	365T	95.6	85.0
100	1800	404T	95.7	81.9
125	1800	405T	96.0	84.5

HP	Nominal RPM (Syn)	Power Frame	Minimum % NEMA 3/4 Load	Minimum % Efficiency Factor 3/4 Load
150	1800	444T	96.2	84.0
200	1800	445T	96.4	82.0
1	3600	143T	79.5	77.2
1-1/2	3600	143T	83.3	72.5
2	3600	145T	85.3	83.8
3	3600	145T	87.0	87.8
5	3600	182T	89.8	81.8
7-1/2	3600	184T	90.4	83.0
10	3600	213T	91.3	84.0
15	3600	215T	92.0	85.0
20	3600	254T	92.5	84.8
25	3600	256T	93.6	91.8
30	3600	284T	93.9	85.3
40	3600	286T	94.5	80.0
50	3600	324T	93.6	93.6
60	3600	326T	94.3	87.6
75	3600	364T	94.5	92.8
100	3600	365T	95.0	82.0
125	3600	404T	95.4	87.1
150	3600	405T	95.4	90.4
200	3600	444T	95.4	85.0

3.5 VIBRATION

A. Statically and dynamically balance motors to a vibration displacement not to exceed 2 mils peak to peak.

B. See Section 220800 – Commissioning of Plumbing.

END OF SECTION 220513

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flexible pipe connectors.
2. Expansion joints.
3. Expansion compensators.
4. Pipe alignment guides.
5. Swivel joints.
6. Pipe anchors.

1.2 DEFINITIONS

A. WOG: Water, Oil, Gas.

1.3 DESIGN REQUIREMENTS

A. Provide structural Work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

B. Expansion Compensation Design Criteria:

1. Installation Temperature: 50 degrees F.
2. Hot Water: 140 degrees F.
3. Safety Factor: 30 percent.

1.4 SUBMITTALS

A. Product Data (PD)

1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

B. General (G)

1. Manufacturer's Installation Instructions: Special procedures.

C. Quality Control Reports (QCR)

1. Manufacturer's Certificate: Products meet or exceed specified requirements.
2. Welders' Certificate: Include welders' certification of compliance with ASME Section IX and AWS D1.1.
3. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit adjustment instructions.

1.6 QUALITY ASSURANCE

A. Perform Work according to ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Manufacturer: Company specializing in manufacturing products specified in this Section with three years' experience.

C. Installer: Company specializing in performing Work of this Section with three years' experience.

1.7 WARRANTY

A. Furnish five-year manufacturer warranty for leak-free performance of packed expansion joints.

1.8 EXTRA MATERIALS

A. Two 12-ounce (340 g) containers of packing lubricant and cartridge style grease gun.

PART 2 - PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:

1. Mason Industries, Inc.
2. Flex-Hose Co., Inc.
3. Metraflex Co.

B. Steel Piping:

1. Inner Hose: Stainless Steel.
2. Exterior Sleeve: Braided stainless steel.
3. Pressure Rating: 200 psig WOG and 250 degrees F.
4. Joint:

    a. NPS 2 Inches and Smaller: Threaded steel-pipe nipple.

b. NPS 2-1/2 Inches and Larger: Flanged steel nipple.

C. Copper Piping:

1. Inner Hose: Bronze.
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: 200 psig WOG and 250 degrees F.
4. Joint:

a. NPS 2 Inches and Smaller: Threaded copper pipe or plain-end copper tube.
b. NPS 2-1/2 Inches and Larger: Flanged copper alloy.

2.2 EXPANSION JOINTS

A. Manufacturers:

1. Mason Industries, Inc.
2. Flex-Hose Co., Inc.
3. Metraflex Co.

B. Stainless Steel Bellows Type:

1. Pressure Rating: 200 psig WOG and 250 degrees F.
2. Maximum Compression: 1-3/4 inch.
3. Maximum Extension: 1/4 inch (6 mm).
4. Joint:

a. NPS 2 Inches and Smaller: Threaded.
b. NPS 2-1/2 Inches and Larger: Flanged.
c.

5. Application: Steel piping 3 inch and smaller.

C. External Ring Controlled Stainless Steel Bellows Type:

1. Pressure Rating: 200 psig WOG and 250 degrees F.
2. Maximum Compression: 1-1/4 inch.
3. Maximum Extension: 3/8 inch.
4. Maximum Offset: 5/16 inch.
5. Joint: Flanged.
6. Accessories: Internal flow liner.
7. Application: Steel piping 3 inch and larger.

D. Double Sphere, Flexible Compensators:

1. Body: Teflon or Neoprene and nylon.
2. Working Pressure: 200 psig.
3. Maximum Temperature: 250 degrees F.
4. Maximum Compression: 3/4 inch.
5. Maximum Elongation: 5/8 inch.
6. Maximum Offset: 1/2 inch.
7. Maximum Angular Movement: 30 degrees.

8. Joint: Galvanized flanges or unions.
9. Accessories: Control rods.
10. Application: Steel piping 2 inch (75 mm) and larger.

E. Two-ply Bronze Bellows Type:

1. Construction: Bronze with anti-torque device, limit stops, internal guides.
2. Pressure Rating: 200 psi WOG and 250 degrees F.
3. Maximum Compression: 1-3/4 inch.
4. Maximum Extension: 1/4 inch (6 mm).
5. Joint:

    a. NPS 2-1/2 Inches and Smaller: Soldered.
    b. NPS 3 Inches and Larger: Flanged.
    c.

6. Application: Copper piping.

F. Low Pressure Compensators with two-ply Bronze Bellows:

1. Working Pressure: 80 psig.
2. Maximum Temperatures: 250 degrees F.
3. Maximum Compression: 1/2 inch (12.7 mm).
4. Maximum Extension: 5/32 inch (4.0 mm).
5. Joint:

    a. Copper NPS 2 Inches and Smaller: Soldered.
    b. Steel NPS 2 Inches and Smaller: Threaded.
    c.

6. Application: Copper or steel piping 2 inch (50 mm) and smaller.

G. Copper with Packed Sliding Sleeve:

1. Maximum Temperature: 250 degrees F (121 degrees C).
2. Joint: Flanged.
3. Application: Copper or steel piping 2 inch (50 mm) and larger.

2.3 ACCESSORIES

A. Manufacturers:

1. Mason Industries, Inc.
2. Flex-Hose Co., Inc.
3. Metraflex Co.

B. Pipe Alignment Guides: Two-piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install Work according to applicable ASME code.

B. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolators. Provide line size flexible connectors.

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

D. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.

E. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required. Refer to Section 220529 for pipe hanger installation requirements.

F. Provide grooved piping systems with minimum one joint per inch (25 mm) pipe diameter instead of flexible connector supported by vibration isolation. Grooved piping systems need not be anchored.

G. Provide expansion loops as indicated on Drawings.

H. Install all flexible pipes and accessories per manufacturer’s recommendations.

END OF SECTION 220516

SECTION 220519 – METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water Meters.
2. Pressure Gauges.
3. Thermometers.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit manufacturer's literature and data including full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
2. Product certificates for each type of meter and gage.

B. Operations and Maintenance manual shall be included in final O&M Manuals provided to CAWCD. Include:

1. System Description.
2. Troubleshooting and preventive maintenance guidelines.
3. Spare parts information.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES FOR WATER AND SEWAGE USAGE

A. ASME B40.100 all metal case 4-1/2 inches diameter, bottom connected throughout, graduated as required for service, and identity labeled. Range shall be 0 to 200 psig gauge.

B. The pressure element assembly shall be bourdon tube. The mechanical movement shall be lined to pressure element and connected to pointer.

C. The dial shall be non-reflective aluminum with permanently etched scale markings graduated in kPa and psig.

D. The pointer shall be dark colored metal.

E. The window shall be glass.

F. The ring shall be brass or stainless steel.

G. The accuracy shall be grade A, plus or minus 1 percent of middle half of scale range.

H. The pressure gauge for domestic water use shall conform to NSF 61.

2.2 THERMOMETERS

A. ASME B40.200 straight stem, metal case, glass tube with red liquid-filled thermometer, approximately 9 inches high, Range shall be 40 degrees F to 212 degrees F.

B. The tube background shall be non-reflective aluminum with permanently etched scale markings graduated in degrees F and degrees C.

C. The accuracy shall be plus or minus 1 percent of span.

D. Thermometers for domestic water use shall conform to NSF 61.

2.3 WATER METERS

A. Contractor shall provide water meter as directed by project documents.

B. Displacement Water Meters:

1. AWWA C700, nutating disc; totalizing meter with bronze case, threaded or flanged ends, and registration in gallons.
2. Pressure Rating: 150-psig.

C. Turbine Water Meters:

1. AWWA C701, turbine; totalizing meter with bronze case, threaded or flanged ends, and registration in gallons.
2. Pressure Rating: 150-psig.

D. Compound Water Meters:

1. AWWA C702, totalizing meter with integral mainline and bypass, bronze case, flanged ends, and registration in gallons.
2. Pressure Rating: 150-psig.

E. Ultrasonic Water Meters:

1. AWWA C700, ultrasonic open flow tube; totalizing meter with bronze case, threaded or flanged ends, and registration in gallons.
2. Pressure Rating: 150-psig.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pressure Gauges:

1. Direct mounted pressure gauges shall be installed in piping tees with pressure gauge located on pipe at the most readable position.
2. Valves and snubbers shall be installed in piping for each pressure gauge.
3. Pressure gauges shall be installed where indicated on the drawings and at the following locations:

    a. Suction and discharge of each domestic water pump or re-circulating hot water return pump.

B. Thermometers:

1. Thermometers shall be installed on the water heater inlet and outlet piping, thermostatic mixing valve outlet piping, hot water circulation pump inlet piping, and domestic water heat exchanger inlet and outlet piping. Provide thermowells with extension on insulated piping.
2. Fill thermowells with heat-transfer medium.

C. If an installation is unsatisfactory to the CAWCD's Representative, the Contractor shall correct the installation at no cost to CAWCD.

3.2 FIELD QUALITY CONTROL

A. The meter assembly shall be visually inspected and operationally tested. The correct multiplier placement on the face of the meter shall be verified.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR SERVICE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.
4. Globe Valves.
5. Chainwheels.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. SWP: Steam working pressure.

1.3 SUBMITTALS

A. Product Data (PD):

1. Submit manufacturer's catalog information with valve data and ratings for each service.

B. Manufacturer's Installation Instructions:

1. Submit hanging and support methods, joining procedures.

C. Shop Drawings (SD):

1. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

D. Operation and Maintenance Data:

1. Include in final O&M Manuals provided to CAWCD.

1.4 QUALITY ASSURANCE

A. For drinking water service, provide valves complying with NSF 61.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for service piping and equipment.

1.5 QUALIFICATIONS

A. Manufacturer:

1. Company specializing in manufacturing Products specified in this section with five years documented experience.
2. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Provide temporary protective coating on cast iron and steel valves if required.
4. Set globe valves closed to prevent rattling.
5. Set ball valves open to minimize exposure of functional surfaces.
6. Set butterfly valves closed or slightly open.
7. Block check valves in either closed or open position.

B. Use the following precautions during storage:

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

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

1.7 WARRANTY

A. Furnish five-year manufacturer warranty for valves excluding packing. Warranty date shall begin at date of start-up.

1.8 EXTRA MATERIALS

A. Provide two packing kits for each size valve 6 inches and larger.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

B. Valves NPS 2-1/2 inches and smaller shall be ball type Unless otherwise specified.

C. Valves NPS 3 inches and larger shall be OS&Y gate valve unless otherwise specified by contract drawings or approved otherwise by CAWCD.

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

E. Substitutions: Permitted as approved by CAWCD.

F. Valve Actuator Types:

1. Handwheel: For valves other than quarter-turn types. Quarter-turn valves NPS 6" and larger shall be supplied with a gear box and handwheel operator.
2. Hand Lever: For quarter-turn valves NPS 6 and smaller.
3. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

G. Valves in contact with domestic water systems shall be certified to NSF/ANSI 61 Annex F & G, and NSF/ANSI 372.

H. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: With extended neck.
3. OS&Y Gate Valves: Do not require extensions, however, insure that insulation doesn't interfere with rotation of valve stem.

I. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.
4. Non-flanged valves shall have union fittings installed upstream and downstream to add orientation and removal for maintenance.

    a. Exception: 3-piece threaded valves do not require additional union fittings.

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

2.2 BALL VALVES

A. Brass Ball Valves:

1. Manufacturers:

a. NIBCO INC.
b. Milwaukee Valve Company.
c. Conbraco Industries, Inc.; Apollo Valves.
d. Crane Co.; Crane Valve Group; Crane Valves.

2. NPS 2 inches and Smaller: MSS SP 110, Class 150, 150 SWP, 600 CWP, two-piece bronze body, stainless steel trim, full port, teflon seats, blow-out proof stem, soldered or threaded ends, lever handle with balancing stops.
3. NPS 2-1/2 inches to NPS 4 inches: MSS SP 110, Class 150, 150 SWP, 400 CWP, two-piece bronze body, stainless steel trim, full port, teflon seats, blow-out proof stem, soldered or threaded ends**,** lever handle with balancing stops.

2.3 BUTTERFLY VALVES

A. Iron Butterfly Valves:

1. Manufacturers:

a. Bray Controls; a division of Bray International.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Val-Matic Valve and Manufacturing Company; a subsidiary of A.Y. McDonald Industries.

2. NPS 3 inches to NPS 24 inches: MSS SP67, AWWA C504 or API 609 Complaint, Class 150, 150 CWP,

a. Body: A126 Cast Iron or A536 Ductile Iron, coated in accordance with AWWA C550, Lug or Wafer Type.
b. Stem: Stainless Steel Stem.
c. Disc: Aluminum Bronze, or 304 or 316 Stainless Steel.
d. Seat: Resilient Seat, EPDM or Nitrile Rubber, either on the valve body or on the disc. Valves NPS 12 and larger must have replaceable mechanically retained seats.

3. Handle and Operator: Provide 10 position lever handle for throttling applications only. For valves NPS 6 and larger, furnish gear operators. For valves more than 8 feet above finished floor or grade, furnish chain-wheel operators.

2.4 CHECK VALVES

A. CK-1 Check Valve: Bronze Swing Check Valves

1. Manufacturers:

a. NIBCO INC.
b. Milwaukee Valve Company.
c. Crane Co.; Crane Valve Group.

2. Size NPS 1/4 to NPS 2-1/2: MSS SP 80 Type 3, Class 125, 200 CWP, Horizontal Flow, ASTM B 62 bronze body, cap, and disc, teflon seat, threaded ends.

B. CK-2 Check Valve: Iron Swing Check Valves with Closure Control

1. Manufacturers:

a. Val-Matic; Surgebuster
b. Crane Co.
c. NIBCO INC.

2. NPS 2-1/2 to NPS 12: AWWA C508 or MSS SP 71, Class 125, 200 CWP, Clear or full waterway body design, ASTM A536 ductile iron body, bronze or Buna-N swing disc, renewable disc seal and seat, asbestos free gaskets, flanged ends, factory-installed spring closure assist.

C. CK-3 Check Valve: Center-Guided, Spring-Loaded Check Valves (Silent Check Valves)

1. Manufacturers:

a. Val-Matic Valve and Manufacturing Company; a subsidiary of A.Y. McDonald Industries.
b. Flomatic Valves; Flomatic Corporation.
c. WATTS; A Watts Water Technologies Company.
d. Milwaukee Valve Company

2. MSS SP 125, Class 125, 200 CWP, ASTM B-584 lead free bronze or ASTM A536 ductile iron body, spring loaded globe or wafer style with ASTM B-584 lead free bronze disc and stem and globe style supplied with flanged ends.

D. CK-4 Check Valve: Double Check Valve Assembly, Backflow Preventer for Potable Water Systems:

1. Primary Application: Prevent the contamination of potable water systems due to back-siphonage or back pressure for: connections from potable water to HVAC and Hydronic Systems for make-up water lines, connections from potable water system to landscape irrigation systems, etc.
2. Manufacturers:

a. WATTS; A Watts Water Technologies Company
b. Zurn Wilkins
c. Apollo Valves, Aalberts Integrated Piping Systems

3. NPS 1/2 to NPS 2: AWWA C510 and ASSE 1015-2011, Class 150, lead free bronze body and caps, provided with isolating ball valves for maintenance and SAE threaded test cocks, with y-strainer on inlet, approved for both horizontal and vertical use.

2.5 GLOBE VALVES

A. Bronze Globe Valves:

1. Manufacturers:

    a. NIBCO INC.
    b. Milwaukee Valve Company.
    c. Crane Co.; Crane Valve Group.

2. GB-1 MSS SP 80 Type 1, Class 150, 200 CWP, ASTM B 62 bronze body with integral seat and screw-in bonnet, bronze stem and disc, Asbestos free packing, soldered or threaded ends, malleable iron handwheel.

2.6 GATE VALVES

A. GV-1 Gate Valve: OS&Y Bronze Gate Valves (Non-Potable Water)

1. Manufacturers:

    a. Milwaukee Valve Company
    b. NIBCO INC.
    c. Or CAWCD approved equal.

2. NPS 1/4 to NPS 3: MSS SP-80 Type 2, Class 150, ASTM B62 bronze body and wedge and bonnet, ASTM B62 rising bronze stem, full port, NPT threaded ends, malleable iron hand wheel, graphite packing.

B. GV-2 Gate Valve: OS&Y Bronze Gate Valves (Potable Water)

1. Manufacturers:

    a. Milwaukee Valve Company.
    b. NIBCO INC.
    c. Or CAWCD approved equal.

2. NPS 1/4 to NPS 2: MSS SP-80 Type 2, Class 150, ASTM B584 C89833 bronze body and wedge and bonnet, ASTM B21 C46400 H02 rising brass stem, full port, NPT threaded ends, malleable iron hand wheel, graphite packing.

    a. Valves used for potable water service must be lead free and NSF 61 certified.

C. GV-3 Gate Valve: Ductile Iron Gate Valves – Resilient Seated

1. Manufacturers:

    a. Kennedy Valve
    b. Crispin Valve
    c. NIBCO INC.
    d. Or CAWCD approved equal.

2. NPS 2 to NPS 24 Class 125 or 250 (Ductile Iron): AWWA C515 or MSS SP-128 Type 2, Solid Wedge with Resilient Seat, Outside Screw and Yoke (Preferred), Flanged ends. ASTM A395, A584 or A536 Ductile Iron Body and Wedge and Bonnet, EPDM Rubber Molded seat on wedge per ASTM D429, rising stainless-steel (ASTM A276), Brass (ASTM B371) or Silicon Bronze (ASTM B98 C65500)

stem, full port, flat-face flanges per ASME B16.5, malleable iron hand wheel, graphite packing, NSF 61 certified when required by project documents.

D. GV-4 Gate Valve: OS&Y Cast Iron Gate Valves – Metal Seated

1. Manufacturers:

a. NIBCO INC.
b. Milwaukee Valve Company.
c. Or CAWCD approved equal.

2. NPS 2 to NPS 12 Class 125 or 250 (Cast Iron): MSS SP-70 Type 1, Solid Wedge with Outside Screw and Yoke, Flanged ends. ASTM A126 Cast Iron Body and Wedge and Bonnet, ASTM B62 cast bronze seat ring and face rings, rising bronze or ASTM B16 brass stem, full port, flat-face flanges per ASME B16.5, malleable iron hand wheel, graphite packing.

E. GV-5 Gate Valve: OS&Y Ductile Iron Gate Valves – Metal Seated

1. Manufacturers:

a. NIBCO INC.
b. Or CAWCD approved equal.

2. NPS 2 to NPS 12 Class 150 or 300 (Ductile Iron): MSS SP-128 Type 1, Solid Wedge with Outside Screw and Yoke, Flanged Ends. ASTM A395 or A536 Ductile Iron Body and Wedge and Bonnet, ASTM B584 Copper Alloy seat ring and face rings, ASTM B371 brass stem, full port, raised-face flanges per ASME B16.5, cast or malleable iron hand wheel, graphite packing.

F. GV-6 Gate Valve: OS&Y Cast Steel Gate Valves – Metal Seated

1. Manufacturers:

a. Milwaukee Valve Company
b. Or CAWCD approved equal.

2. NPS 2 to NPS 24 Class 150 or 300 (Cast Steel): API 600, Split Wedge with Outside Screw and Yoke, Flanged Ends. ASTM A216 Cast Steel Body and Wedge and Bonnet, raised-face flanges per ASME B16.5, ASTM A105 ferrous seat ring and face rings, ASTM A182 stainless steel stem, full port, raised-face flanges per ASME B16.5, malleable iron hand wheel, graphite packing.

2.7 AIR RELEASE AND VACUUM RELEASE VALVES

A. AR-1 Air Release Valve: Air Release Valves for Potable Water

1. Manufacturers:

a. Crispin Valve.
b. Val-Matic Valve and Manufacturing Company; a subsidiary of A.Y. McDonald Industries.

c. DeZurik
d. Or CAWCD approved equal.

2. NPS 1/2 to NPS 6: AWWA C512, Class 150, A126 or A216 cast iron body and top cover, ASTM A240 Stainless Steel Float, Buna-N Rubber Seat or A582 Stainless-Steel Seat, NPT threaded inlet and exhaust ports, NSF 61 certified when required by project documents.

B. AV-1 Air Vacuum Valve: Combination Vacuum/Air Release Valve for Potable Water

1. Manufacturers:

a. Crispin Valve.
b. Val-Matic Valve and Manufacturing Company; a subsidiary of A.Y. McDonald Industries.
c. DeZurik
d. Or CAWCD approved equal.

2. NPS 1/2 to NPS 12: AWWA C512, Class 150, ASTM A126 Cast Iron or ASTM A536 Ductile Iron body and top cover, ASTM A240 Stainless-Steel Float, Buna-N Rubber Seat, NPT threaded inlet and exhaust ports.

C. AV-2 Air Vacuum Valve: Combination Vacuum/Air Release Valve for Potable Water

1. Manufacturers:

a. Crispin Valve.
b. Val-Matic Valve and Manufacturing Company; a subsidiary of A.Y. McDonald Industries.
c. DeZurik
d. Or CAWCD approved equal.

2. NPS 2 to NPS 6: AWWA C512, Class 150, ASTM A240 Stainless-Steel body and top cover, ASTM A240 Stainless Steel Float, Buna-N Rubber Seat, NPT threaded inlet and exhaust ports.

2.8 CHAINWHEELS

A. Manufacturers:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description:

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to butterfly valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage. Gaskets and bolts shall comply with 220503.

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

3.2 VALVE INSTALLATION

A. Install valves with stems upright or horizontal, not inverted. Install valves in horizontal piping with stem at or above center of pipe.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown. Locate valves for easy access and provide separate support where necessary. Valves shall be no more than 6 feet above floor unless otherwise approved by CAWCD.

C. Install valves with clearance for installation of insulation and allowing access.

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

E. Install 3/4-inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

F. Install chain wheels on operators for isolation valves more than 96 inches above floor. Extend chains to 60 inches above finished floor.

G. Install swing check valves for proper direction of flow, in horizontal position with hinge pin level.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. Install valves at locations indicated on Drawings and according to this Section.

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

1. Shutoff Service: Ball, rising stem gate valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: globe, or butterfly valves.
4. Pump-Discharge Check Valves:

    a. NPS 2-1/2 and Larger: Iron swing check valves.

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

D. Select valves for copper pipe and tube, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Wafer Valves: Use two-piece companion flanges on pipe ends.

3.5 PLANT PIPING VALVE SCHEDULE

A. See Special Provisions or Project Drawings for valve schedule.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR SERVICE PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports
2. Trapeze pipe hangers
3. Fiberglass pipe hangers
4. Pipe stands
5. Equipment supports
6. Fastener systems
7. Sleeves
8. Mechanical sleeve seals
9. Formed steel channel

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit data for each type of product. Submit manufacturers catalog data including load capacity.

B. Shop Drawings (SD):

C. Show fabrication and installation details and include calculations for the following. Include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

1.3 QUALITY CONTROL REPORTS (QCR):

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

1.4 QUALITY ASSURANCE

A. Hangers and supports shall conform to the requirements of the following codes and standards as applicable:

1. ASME B31.1, Power Piping
2. ASME B31.3, Process Piping

3. ASME B31.9, Building Services Piping
4. International Mechanical Code, (IMC)
5. International Plumbing Code, (IPC)
6. NFPA 13, Standard for the Installation of Sprinkler System

1.5 QUALIFICATIONS

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

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.6 FIELD MEASUREMENTS

A. Verify all field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design trapeze pipe hangers and equipment supports.

B. Structural Performance for Piping and Equipment: Hangers and supports for piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

C. Seismic Design: Pipe hangers and supports shall be a delegated design to withstand the effects of gravity and seismic loads and stresses within limits under conditions described in ASCE/SEI 7.

1. Risk Category III
2. Seismic Design Category E

D. The use of pipe hooks, chains, perforated iron strapping, or wire for pipe supports are NOT permitted.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components
2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

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

2.3 TRAPEZE PIPE HANGERS

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

1. Hanger rods shall be minimum 3/8-inch diameter.

2.4 PIPE STANDS

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

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

2.5 EQUIPMENT SUPPORTS

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

2.6 MATERIALS

A. Aluminum: ASTM B221

B. Carbon Steel: ASTM A1011/A1011M

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

D. Stainless Steel: ASTM A240/A240M

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods

F. Grout: Refer to CAP Standard Specification 509 – Placement of Non-Shrink Cementitious Grout.

2.7 PIPE HANGERS AND SUPPORTS

A. MSS SP-58, Types 1 through 58, factory-fabricated components.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.

C. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.

D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

E. Wall Support for Pipe Sizes 3 inches and Smaller: Strut clamp or cast iron hook.

F. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.

G. Vertical Support: Steel riser clamp.

H. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

I. Copper Pipe Support: MSS SP-58, Types 1 through 59, either non-metallic coating jacket or liner, or copper-plated, on steel factory-fabricated components.

2.8 FASTENER SYSTEMS

A. Fasteners: Appropriately rated bolts, nuts, and washers made of carbon steel. In wet areas, stainless-steel fasteners shall be used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, hot dipped galvanized-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. In wet areas, stainless-steel anchors shall be used.

C. Manufacturers: Hilti or approved equal.

2.9 SLEEVES

A. Sleeves for Pipes through Non-Fire Rated Beams, Walls, Footings, and Floors: Schedule 40 steel pipe or 18 gage galvanized steel. Sleeves shall be of sufficient size for pipe and insulation to pass through with minimum 1/4-inch clearance.

B. Comply with requirements in Section 078400 "Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

2.10 MECHANICAL SLEEVE SEALS

A. Product Description:

1. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
2. Assemble links solely with stainless steel bolts and nuts to form a continuous rubber belt around the pipe.
3. Provide a stainless steel or glass reinforced nylon pressure plate under each bolt head and nut. Isolate pressure plate from contact with wall sleeve.

2.11 FORMED STEEL CHANNEL

A. Meet or exceed requirements of MFMA-4, Metal Framing Manufactures Association, factory-fabricated components for field assembly.

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

1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. ERICO International Corporation.
3. Thomas & Betts Corporation.
4. Unistrut; Tyco International, Ltd.

C. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

D. Channel Dimensions: Selected for applicable load criteria.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078400 "Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

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

C. Do not use powder-actuated anchors.

D. Core drilling or saw cutting existing CAWCD infrastructure requires an CAWCD approved Core Drill Permit before proceeding. See section 220500 for additional information.

3.2 INSTALLATION OF PIPE HANGERS AND SUPPORTS

A. Support and Hangar Installation General Guidelines:

1. Ceiling mounted hangers must not extend more than halfway between the distance from ceiling to finished floor unless detailed otherwise on project drawings or approved by CAWCD. If support is required at this elevation, switch to floor mounted pipe stand or support.
2. Piping within 18 inches of existing walls must be supported by wall mounted pipe support unless detailed otherwise on project drawings or approved by CAWCD.
3. Valves:

    a. Valves more than 200 lbs must be supported by dedicated pipe supports. Valve supports must restrain torsional loads imparted on piping, especially for valves mounted with stems horizontal on piping systems.
    b. Bolt on style flange supports are preferred.
    c. Valve supports shall not interfere with bonnet or packing gland removal for future maintenance work.

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

C. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

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

F. Fastener System Installation:

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

G. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.

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

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

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

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

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

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

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes table 704.1 of 2018 International Plumbing Code and to not exceed maximum pipe deflections allowed per applicable codes.

O. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed per applicable codes.

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. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

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

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick
b. NPS 4: 12 inches long and 0.06 inch thick
c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick
e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick

5. Pipes NPS 2-1/2 and Larger: Include reinforced calcium silicate insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

P. Support piping to maintain its alignment and prevent sagging.

Q. Install hangers with minimum 1/2-inch space between finished covering and adjacent work.

R. Place hangers within 12 inches of each horizontal elbow.

S. Additional pipe hangers or fixed pipe supports, beyond the minimum required by code, may be required to adequately restrain piping thrust loads due to changes in direction (elbows), at automatically closing valves, at check valves, or at dismantling joints. CAWCD reserves the right to request shop drawings of hanger installation certified by the engineer of record piping and valve supports are believed to be inadequate.

T. Support vertical piping with riser clamps secured to the piping and resting on the building structure at each floor.

U. Support riser piping independently of connected horizontal piping.

V. Provide coated, jacketed, or liner on steel hangers and supports for copper piping.

W. Design hangers for pipe movement without disengagement of supported pipe.

3.3 METAL FABRICATIONS

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

B. Field weld connections that cannot be shop welded because of shipping size limitations.

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

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

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

3.5 PAINTING

A. Prime coat exposed steel hangers and supports. Refer to Section 099000.

B. Touchup:

1. 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.

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

2. Clean field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal before touchup painting.
3. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 SLEEVES

A. Provide sleeves for all pipe penetrations through walls, roof, or slab above grade.

B. Neatly cut holes in existing walls, floors, or roof for placement of sleeves. Place sleeve and grout and caulk annular space to provide finished appearance.

C. Extend sleeves through floor slab 2 inches above finished floor level. Caulk sleeves full depth and provide floor plate.

D. Seal space between pipe and sleeve watertight for all sleeves penetrating the roof.

E. Where piping penetrates a fire rated wall or floor, provide fire-stopping insulation so that the assembly when complete retains the fire rating of construction penetrated by the sleeve.

3.7 HANGER AND SUPPORT SCHEDULE

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

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

C. Comply with the International Plumbing Code or MSS SP-58 for all pipe support spacing not otherwise indicated.

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

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

F. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

G. Use stainless steel pipe hangers, and, fiberglass pipe hangers, fiberglass strut systems and stainless steel, corrosion-resistant attachments for hostile environment applications.

H. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

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

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

K. 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-58 Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30
2. Yoke-Type Pipe Clamps (MSS-58 Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS-58 Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS-58 Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS-58 Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS-58 Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8
7. Adjustable, Steel Band Hangers (MSS-58 Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8
8. Adjustable Band Hangers (MSS-58 Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8
9. Adjustable, Swivel-Ring Band Hangers (MSS-58 Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS-58 Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS-58 Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3
12. U-Bolts (MSS-58 Type 24): For support of heavy pipes NPS 1/2 to NPS 30
13. Clips (MSS-58 Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS-58 Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS-58 Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS-58 Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS-58 Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS-58 Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS-58 Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS-58 Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS-58 Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

L. 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-58 Type 8): For support of pipe risers NPS 3/4 to NPS 24
2. Carbon- or Alloy-Steel Riser Clamps (MSS-58 Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps

M. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS-58 Type 13): For adjustment up to 6 inches for heavy loads
2. Steel Clevises (MSS-58 Type 14): For 120 to 450 deg F piping installations
3. Swivel Turnbuckles (MSS-58 Type 15): For use with MSS Type 11, split pipe rings
4. Malleable-Iron Sockets (MSS-58 Type 16): For attaching hanger rods to various types of building attachments
5. Steel Weldless Eye Nuts (MSS-58 Type 17): For 120 to 450 deg F piping installations

N. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS-58 Type 18): For upper attachment to suspend pipe hangers from concrete ceiling
2. Top-Beam C-Clamps (MSS-58 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-58 Type 20): For attaching to bottom flange of beams, channels, or angles
4. Center-Beam Clamps (MSS-58 Type 21): For attaching to center of bottom flange of beams
5. Welded Beam Attachments (MSS-58 Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large
6. C-Clamps (MSS-58 Type 23): For structural shapes
7. Top-Beam Clamps (MSS-58 Type 25): For top of beams if hanger rod is required tangent to flange edge
8. Side-Beam Clamps (MSS-58 Type 27): For bottom of steel I-beams
9. Steel-Beam Clamps with Eye Nuts (MSS-58 Type 28): For attaching to bottom of steel I-beams for heavy loads
10. Linked-Steel Clamps with Eye Nuts (MSS-58 Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions
11. Malleable-Beam Clamps with Extension Pieces (MSS-58 Type 30): For attaching to structural steel
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS-58 Type 31): 750 lb
    b. Medium (MSS-58 Type 32): 1500 lb
    c. Heavy (MSS-58 Type 33): 3000 lb

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

O. 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-58 Type 39): To fill interior voids with insulation that matches adjoining insulation
2. Protection Shields (MSS-58 Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe

P. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS-58 Type 47): Where indicated to control piping movement
2. Spring Cushions (MSS-58 Type 48): For light loads if vertical movement does not exceed 1-1/4 inches
3. Spring-Cushion Roll Hangers (MSS-58 Type 49): For equipping Type 41, roll hanger with springs
4. Spring Sway Braces (MSS-58 Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems
5. Variable-Spring Hangers (MSS-58 Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger

6. Variable-Spring Base Supports (MSS-58 Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support
7. Variable-Spring Trapeze Hangers (MSS-58 Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS-58 Type 54): Mounted horizontally
    b. Vertical (MSS-58 Type 55): Mounted vertically
    c. Trapeze (MSS-58 Type 56): Two vertical-type supports and one trapeze member

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

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

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

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR SERVICE PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Valve Tags.
3. Pipe markers.
4. Equipment Information and Warning Labels.
5. Lockout devices.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit manufacturers catalog literature for each product required.

B. Shop Drawings (SD):

1. Provide a completed schedule for piping identification, valve identification and equipment identification including wording, symbols, letter size, and color coding.
2. Equipment Schedule
3. Piping Schedule
4. Valve Schedule
5. Samples: Two tags, labels, pipe markers, and nameplates of size and type used on Project for approval by CAWCD.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.4 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 EQUIPMENT NAMEPLATES

A. Manufacturers:

1. Brimar Industries Inc.
2. Seton Identification Products.
3. Or Equal.

B. Nameplate Size: Sized to fit text, but not less than 1” high by 3” wide. Minimum letter size of 1/4" for name of units if viewing distance is less than 24”, 1/2” for viewing distances up to 72” and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of the principal lettering.

C. Label per equipment schedule.

D. Indoor Nameplates:

1. Material: 1/16” thick, 2-layer, Rigid Phenolic Plastic, per ASTM D709 Type 1.
2. Color Scheme: Engraved white letters on black contrasting background, unless specified otherwise in project documents.
3. Mounting: Two 3/16” diameter mounting holes and/or adhesive backing.

E. Outdoor Nameplates:

1. Material: 22 gauge engraved stainless steel or brass.
2. Color Scheme: Engraved letters, black filled, unless specified otherwise in project documents.
3. Mounting: Two 3/16” diameter mounting holes and/or adhesive backing.

2.2 VALVE TAGS

A. Manufacturers:

1. Brady.
2. Brimar Industries Inc.
3. Seton Identification.
4. Or Equal.

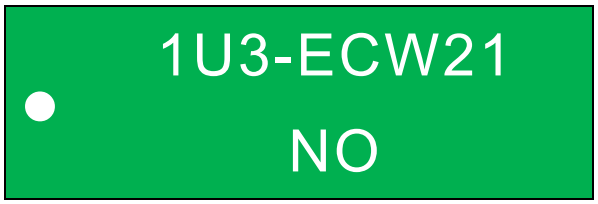
B. Valve Tag Size: 1 inch high by 3 inches wide.

C. Label per approved valve schedule. Valve tags shall be 2-line unless approved otherwise:

1. Line 1: Valve ID Number, example “1U3-ECW21”.

a. Note: 1U3-ECW21 = level 1, Unit 3, Emergency Cooling Water System, Valve Number 21.

2. Line 2: Valve Normal operating position, either “NO” – normally open, “NC” – normally closed, “AUTO” – for an automatically operated valve, or “PRV” – for pressure relief valves.
3. Example Tag:



D. Indoor Valve Tags:

1. Material: 1/16” thick, 2-layer, Rigid Phenolic Plastic, per ASTM D709 Type 1.
2. Color Scheme: Engraved white letters on contrasting background per pipe identification schedule in article 3.3 (based on system service), unless specified otherwise in project documents.
3. Mounting: One 3/16” diameter mounting hole on left side of tag, for use with 1/16” Stainless-steel cable w/ ferrule, length as needed to attach to valve.

E. Outdoor Valve Tags:

1. Material: 22 gauge engraved stainless steel or brass.
2. Color Scheme: Engraved letters, black filled, unless specified otherwise in project documents.
3. Mounting: One 3/16” diameter mounting hole on left side of tag, for use with 1/16” Stainless-steel cable w/ ferrule, length as needed to attach to valve.

2.3 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Manufacturers:

1. Brady.
2. Seton Identification.
3. Or Equal.

C. Product Description

1. Plastic Pipe Markers - Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener. Minimum letter size of 1-1/2 inch.
2. Plastic Tape Pipe Markers - Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Minimum letter size of 1-1/2 inch.
3. Plastic Underground Pipe Markers: - Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
4. Pipe Markers shall indicate the following:

    a. System.

b. Pipe size.
c. Flow direction.

2.4 EQUIPMENT INFORMATION AND WARNING LABELS

A. Manufacturers:

1. Brady.
2. Seton Identification Products.
3. Or Equal.

B. Product Description: Aluminum, Polyester, or Laminated Mylar, size 1.9 x 0.75 inches (48 x 19 mm), adhesive backed with printed identification.

C. Color scheme shall be per ANSI Z535 for safety signs related to piping and plumbing equipment.

2.5 LOCKOUT DEVICES

A. Lockout Hasps:

1. Manufacturers:

a. Brady.
b. Master Lock Company.
c. Or Equal.

2. Product Description - Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches (184 x 76 mm).

B. Valve Lockout Devices:

1. Manufacturers:

a. Brady.
b. Master Lock Company
c. Or Equal.

2. Product Description - Nylon or Steel device preventing access to valve operator, accepting lock shackle.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

A. Install identifying devices after completion of coverings and painting.

B. Install nameplates with corrosive-resistant mechanical fasteners.

C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.

D. Install tags using stainless steel or corrosion resistant chain.

E. Identify all equipment such as pumps, tanks, and water treatment devices, and piping specialties as scheduled or as indicated on the drawings with nameplates.

F. Identify control panels and major control components outside panels with the equipment with nameplates.

G. Identify valves with the valve tag, description, and status as scheduled or indicated on the drawings with tags.

H. For equipment not identified on the drawings coordinate with the CAWCD Contracting Officer for the appropriate label identification. Include the equipment tag number and description on the nameplate. Identify in-line pumps and other small devices with tags.

I. Identify piping, concealed or exposed, with plastic tape pipe markers. Identify service, service description, and flow direction. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

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

K. Locate nameplates, labels, and tags so that they are readily visible from the point of normal approach.

3.3 SCHEDULES

A. Pipe Identification

Service	**Description**	**Letter Color**	**Background Color**
ACBA	Airblast Circuit Breaker Air	White	Blue
AC	Air Chamber	White	Blue
ACR	Air Compressor Room	White	Blue

Service	**Description**	**Letter Color**	**Background Color**
AV	Air Vent (Vacuum)	White	Blue
BA	Break Air	White	Blue
BM	Black Mountain Discharge Pipeline	White	Green
CBA	Circuit Breaker Air	White	Blue
CBP	CAP Bypass	White	Green
CL	Chlorination System	Black	Orange
CLW	Chlorinated Water	White	Green
CO2	Carbon Dioxide	White	Red
DLF	Discharge Line Fill	White	Green
DHW	Discharge Header Water	White	Green
DO	Drip Oil	White	Brown
DPA	Depressing Air	White	Blue
DV	Discharge Valve Air	White	Blue
DVB	Discharge Valve Bypass	White	Green
DVHO	Discharge Valve Hydraulic Oil	White	Brown
DVOA	Discharge Valve Operating Air	White	Blue
DW	Domestic Water	White	Green

Service	**Description**	**Letter Color**	**Background Color**
ECW	Emergency Cooling Water	White	Green
ECW	HVAC Evaporative Cooling Water	White	Green
EG	Emergency Generator Fuel	Black	Yellow
ETV	Equalizing Tube Air Vent	White	Green
FCHO	Fixed Cone Hydraulic Oil	White	Brown
FSW	Fire Suppression Water	White	Red
GOA	Governor Operating Air	White	Blue
GOHO	Governor Hydraulic Oil	White	Brown
HLO	High Pressure Lube Oil	White	Brown
JGHO	Jet Gate Hydraulic Oil	White	Brown
JHO	Jacking Hoist/Hydraulic Oil	White	Brown
JLO	Jacking Lube Oil	White	Brown
LCIC	LCI Drive Coolant System	White	Green
LO	Lube Oil	White	Brown
MBA	Motor Brake Air	White	Blue
MSW	Mechanical Seal Water	White	Blue

Service	**Description**	**Letter Color**	**Background Color**
NCH	Chilled Water	White	Green
NHW	Heating Hot Water	White	Green
NCW	Condenser Water	White	Green
NSW	HVAC Service Water	White	Green
OFW	Oil Storage Fire Water	White	Red
OGHO	Outlet Gates Hydraulic Oil	White	Brown
OFP	Oil Storage Room Fire Protection	White	Red
OWF	Outlet Works Fill	White	Green
OWSW	Outlet Works Service Water	White	Green
PDW	Plant Domestic & Service Water	White	Green
PFP	Plant Fire Protection	White	Red
POT	Potable Water System	White	Green
PPW	Pump Packing Water	White	Green
PSA	Plant Service Air	White	Blue
PSE	Pneumatic Sewage Ejection	White	Green
PSI	Plant Sump Inlet	White	Green

Service	**Description**	**Letter Color**	**Background Color**
PRW	Plant Raw Water	White	Green
PSW	Plant Service Water (Strainer)	White	Green
PWS	Plant Water Systems Supply	White	Green
PZ	Piezometer	White	Green
RLI	River Outlet Lake Indication	White	Green
SBW	Stuffing Box Water	White	Green
SD	Sludge Water	White	Green
SE	Sewage Ejection	White	Green
SFC	Sand Filter Control	White	Green
SFE	Sand Filter Water	White	Green
SGHO	Slide Gate Hydraulic Oil	White	Brown
SO	Sump Oil	White	Brown
SRS	Sewage Removal System	White	Green
SSO	Service Seal Oil	White	Brown
SSW	Shaft Seal Water	White	Green
STA	Sewage Treatment Air	White	Blue
STF	Suction Tube Fill	White	Green

Service	**Description**	**Letter Color**	**Background Color**
ST	Surge Tank	White	TBD
SWO	Sump Waste Oil	White	Brown
TFW	Transformer Fire Water	White	Red
TRG	Trash Rake Gearbox	White	Green
U	Unit Bay	White	Green
UCW	Unit Cooling Water	White	Green
UD	Unit Discharge	White	Green
UW	Unwatering	White	Green
UWS	Unwatering System	White	Green
VHO	Valve Hydraulic Oil	White	Brown
VOA	Valve Operating Air	White	Blue
VOS	Discharge Valve Operating	White	Green
WD	Water Delivery	White	Green
WO	Waste Oil	White	Brown
WQM	Water Quality Monitoring System	White	Green
WGHO	Wheelgate Hydraulic Oil	White	Brown

END OF SECTION 220553

SECTION 220593 - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing, adjusting, and balancing of domestic water system.
2. Testing, adjusting, and balancing of plumbing equipment:
3. Testing, adjusting, and balancing of existing plumbing systems and equipment that are within project scope of work.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.3 ACTION SUBMITTALS

A. Qualification Data: Within 15 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 30 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 30 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.

1.4 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.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE 111 Compliance: Requirements in ASHRAE 111 applicable to analogous domestic water system and plumbing equipment balancing.

D. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."

E. Engage a TAB entity certified by AABC or NEBB.

F. Maintain one copy of each document on site.

G. Prior to commencing Work, calibrate each instrument to be used.

H. Plumbing Commissioning Authority (Section 220800) shall oversee all TAB work taking place. TAB Contractor shall schedule all work with Commissioning Agent for witnessing of testing.

I. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.5 SEQUENCING

A. Sequence balancing between completion of systems tested and Date of Substantial Completion.

B. Perform balancing after leakage and pressure tests on plumbing systems have been satisfactorily completed.

1.6 SCHEDULING

A. Occupancy: CAWCD will occupy the site and existing building during entire TAB period. Cooperate with CAWCD during TAB operations to minimize conflicts with CAWCD’s operations.

B. Schedule and provide assistance in final adjustment and test of plumbing systems with CAWCD Personnel.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine approved submittals for plumbing systems and equipment.

D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.

E. Examine equipment performance data, including pump curves.

1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.

F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine plumbing equipment and verify that bearings are greased and equipment with functioning controls is ready for operation.

I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.

J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

K. Examine system pumps to ensure absence of entrained air in the suction piping.

L. Examine operating safety interlocks and controls on plumbing equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Domestic Water System:

a. Water heaters are installed and functioning.
b. Piping is complete and all points of outlet are installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are clean.
f. Control valves are functioning in accordance with the sequence of operation.
g. Shutoff and balance valves are 100 percent open.
h. Booster and hot water circulating pumps are operational and proper rotation is verified.
i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete, and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

2. Sanitary Sewage/Drainage System:

a. Piping is complete.
b. Sanitary sewage pumps/drainage pumps are operational.
c. Control valves are functioning in accordance with the sequence of operation.
d. Shutoff valves are 100 percent open.
e. Suitable access to equipment is provided.

3. Compressed-Air System:

a. Piping is complete and all points of outlet are installed.
b. Systems are flushed, filled, and air purged.
c. Strainers are clean.
d. Control valves are functioning in accordance with the sequence of operation.
e. Shutoff and balance valves are 100 percent open.
f. Compressors and dryers are operational and of proper rotation.

g. Gauge connections are installed directly at compressor inlet and outlet flanges prior to valves or strainers.
h. Variable-frequency controllers' startup is complete, and safeties are verified.
i. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220700 "Plumbing Insulation."

C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Domestic water booster pumps.
3. Domestic water in-line pumps.
4. Domestic water heaters.
5. Sanitary sewage pumps.
6. Drainage pumps.
7. Air compressors.

3.5 PROCEDURES FOR DOMESTIC WATER SYSTEMS

A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:

1. Check expansion tank for proper setting.
2. Check water heater for proper discharge temperature setting.
3. Check remotest point of outlet for adequate pressure.
4. Check flow-control valves for proper position.
5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
6. Verify that motor controllers are equipped with properly sized thermal protection.
7. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

G. Check settings and operation of each safety valve. Record settings.

3.6 PROCEDURES FOR COMPRESSED-AIR SYSTEMS

A. Prepare test reports for air compressors, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare compressed-air systems for testing and balancing as follows:

1. Check remotest point of outlet for adequate pressure.
2. Check pressure-control valves for proper position.
3. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
4. Verify that motor controllers are equipped with properly sized thermal protection.

D. Measure and record pressure and dewpoint downstream of air compressors and dryers.

E. Measure and record pressure upstream and downstream of pressure-reducing valves.

F. Check settings and operation of air compressors, dryers, and pressure-reducing valves. Record final settings.

G. Check settings and operation of each safety valve. Record settings.

3.7 PROCEDURES FOR DOMESTIC WATER SYSTEM BOOSTER PUMPS

A. Adjust pumps to deliver total design flow.

1. Measure total water flow.

a. Position valves for full flow through coils.
b. Measure flow by main flow meter, if installed.
c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

2. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

D. Verify that memory stops have been set.

3.8 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

A. Balance system with manual or automatic balancing valves by setting at design flow.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

B. Adjust pump to deliver total design flow.

1. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.

c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
3. Mark final settings and verify that all memory stops have been set.
4. Verify final system conditions as follows:

a. Re-measure and confirm that total flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
c. Mark final settings.

3.9 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. 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.

3.10 PROCEDURES FOR WATER HEATERS

A. Electric Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. Measure and record relief valve(s) pressure setting.
5. Capacity: Calculate in Btu/h of heating output.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

B. Gas- and Oil-Fired Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. Measure and record relief valve(s) pressure setting.
5. Capacity: Calculate in Btu/h of heating output.

6. Fuel Consumption: If fuel supply is equipped with flow meter, measure and record consumption.
7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
8. Fan, motor, and motor controller operating data.

3.11 TOLERANCES

A. Set plumbing system's flow rates within the following tolerances:

1. Domestic Water Flow Rate: Plus or minus 10 percent. If design value is less than 10 gpm, within 1 gpm.
2. Compressed-Air Flow Rate: Plus or minus 10 percent. If design value is less than 10 scfm, within 1 scfm.

3.12 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.13 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. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. 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. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for pump performance forms, including the following:

    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:

1. Flow rates.
2. Pipe and valve sizes and locations.
3. Balancing stations.
4. Position of balancing devices.

E. Gas- and Oil-Fired Water Heaters Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Fuel type in input data.
    g. Output capacity in Btu/h.
    h. Ignition type.
    i. Burner-control types.
    j. Motor horsepower and speed.
    k. Motor volts, phase, and hertz.
    l. Motor full-load amperage and service factor.

2. Test Data (Indicated and Actual Values):

a. Entering-water temperature in deg F.
b. Leaving-water temperature in deg F.
c. Low-fire fuel input in Btu/h.
d. High-fire fuel input in Btu/h.
e. High-temperature-limit setting in deg F.
f. Operating set point in Btu/h.
g. Heating value of fuel in Btu/h.

F. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Model number and unit size.
d. Manufacturer's serial number.
e. Output capacity in Btu/h.
f. Number of stages.
g. Connected volts, phase, and hertz.
h. Rated amperage.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. High-temperature-limit setting in deg F.
e. Operating set point in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

G. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water-pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump speed.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.

p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

H. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.14 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.

B. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 20 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.

2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.15 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 220593

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plumbing piping insulation, jackets, and accessories.
2. Plumbing equipment insulation, jackets, and accessories.

1.2 SUBMITTALS

A. Product Data (PD):

1. Submit product description, thermal characteristics, list of materials, thickness for each service, and location.
2. Submit manufacturers published literature indicating proper installation procedures.

B. Shop Drawings (SD):

1. Include plans, elevations, sections, details, and attachments to other work.
2. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
3. Detail insulation application at elbows, fittings, dampers, specialties, and flanges for each type of insulation.
4. Detail application of field applied jackets.
5. Detail application at linkages of control devices.

C. Samples (S):

1. Submit two samples of representative size illustrating each insulation type.

1.3 QUALITY ASSURANCE

A. Contractor shall provide certification indicating insulation has a maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84

1. Surface burning characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency approved by CAWCD. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

a. Insulation installed indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

b. Insulation installed outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

1.4 QUALIFICATIONS

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

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

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

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 WARRANTY

A. Furnish five-year manufacturer warranty for man-made fiber.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Manufacturers; Glass Fiber and Mineral Fiber Insulation:

1. Johns Manville; a Berkshire Hathaway company

2. Owens Corning
3. Manson Insulation Inc.

B. Manufacturers; Closed Cell Elastomeric Insulation:

1. Aeroflex USA
2. Armacell LLC
3. K-Flex USA

2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE P-2: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.26 at 75 degrees F for up to 1 inch wall.
2. Maximum Service Temperature: 220 degrees F.
3. Operating Temperature Range: Minus 60 to 220 degrees F.

2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:

1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water vapor transmission: ASTM E96/E96M; 0.02 perm-inches.

B. PVC Plastic Pipe Jacket:

1. Product Description: ASTM D1785, one piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 30 mil.
3. Connections: Pressure sensitive color matching vinyl tape and vapor retarder mastic.

C. ABS Plastic Pipe Jacket:

1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
2. Minimum service temperature: -40 degrees F.
3. Maximum service temperature of 180 degrees F.
4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
5. Thickness: 30 mil.
6. Connections: Brush on welding adhesive.

D. Aluminum Pipe Jacket:

1. ASTM B209.
2. Thickness: 0.016-inch-thick sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2-inch laps.
5. Fittings: 0.016-inch-thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 1/2 inch wide; 0.020-inch-thick stainless steel.

E. Stainless Steel Pipe Jacket:

1. ASTM A240/A240M OR ASTM 666 Type 304 or 316 stainless steel.
2. Thickness: 0.018inch thick.
3. Finish: Smooth.
4. Metal Jacket Bands: 1/2 inch wide; 0.020-inch-thick stainless steel.

F. Field Applied Glass Fiber Fabric Jacket System:

1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:

    a. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
    b. Blanket: 1.0 lb/cu ft (16 kg/cu m) density.
    c. Weave: 5 x 5.

3. Indoor Vapor Retarder Finish:

    a. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
    b. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with stainless steel jacket single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048-inch stainless steel with twisted ends on maximum 12 inch centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C612; glass fiber, rigid board, noncombustible with factory applied reinforced aluminum foil jacket.

1. Thermal Conductivity: 0.24 at 75 degrees F.
2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: 3.0 pound per cubic foot.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

2.6 EQUIPMENT INSULATION JACKETS

A. PVC Plastic Equipment Jacket:

1. Product Description: ASTM D1785, sheet material, off-white color.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 150 degrees F.
4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
5. Thickness: 20 mil.
6. Connections: Pressure sensitive color matching vinyl tape.

B. Aluminum Equipment Jacket:

1. ASTM B209Thickness: 0.032-inch-thick sheet.
2. Finish: Embossed.
3. Joining: Longitudinal slip joints and 2-inch laps.
4. Fittings: 0.016-inch-thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.010-inch-thick stainless steel.

C. Stainless Steel Equipment Jacket:

1. ASTM A240/A240M OR ASTM 666 Type 304 or 316 stainless steel.
2. Thickness: 0.018inch thick.
3. Finish: Corrugated.
4. Metal Jacket Bands: 3/8 inch wide; 0.010inch thick stainless steel.

D. Canvas Equipment Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

E. Vapor Retarder Jacket:

1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water vapor transmission: ASTM E96/E96M; 0.02 perm-inches.

F. Field Applied Glass Fiber Fabric Jacket System:

1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:

a. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
b. Blanket: 1.0 lb/cu ft (16 kg/cu m) density.
c. Weave: 5 x 5.

3. Indoor Vapor Retarder Finish:

a. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
b. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.7 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Tie Wire: 0.048-inch (1.22 mm) stainless steel with twisted ends on maximum 12-inch (300 mm) centers.

D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

E. Adhesives: Compatible with insulation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify piping and equipment has been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 078400 for penetrations of assemblies with fire resistance rating greater than one hour.

C. Piping Systems Conveying Fluids Below Ambient Temperature:

1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and

butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Hot Piping Systems less than 140 degrees F:

1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

E. Hot Piping Systems greater than 140 degrees F:

1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

F. Inserts and Shields:

1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.

    a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
    b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.

3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

G. Closed Cell Elastomeric Insulation:

1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer’s recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

H. High Temperature Pipe Insulation:

1. Cover with stainless steel jacket with seams located on bottom side of horizontal piping.

I. Finish Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor) with:

1. Canvas jacket sized for finish painting.
2. PVC jacket and fitting covers.
3. ABS jacket and fitting covers.
4. Aluminum jacket.
5. Stainless steel jacket.

J. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum and stainless steel jackets with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

K. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

L. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.

M. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with stainless steel jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

N. Prepare pipe insulation for finish painting. Refer to Section 099000.

3.3 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:

1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and

butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees F Or Less:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment Containing Fluids Over 140 degrees F:

1. Insulate flanges and unions with removable sections and jackets.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

G. Finish Equipment in Mechanical Equipment Rooms or Finished Spaces with:

1. canvas jacket sized for finish painting
2. PVC jacket and fitting covers
3. aluminum jacket
4. stainless steel jacket.

H. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with stainless steel jacket with seams located on bottom side of horizontal equipment.

I. Cover glass fiber, cellular glass, hydrous calcium silicate, cellular foam insulation with stainless steel jacket.

J. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

K. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

L. Prepare equipment insulation for finish painting. Refer to Section 099000.

3.4 SCHEDULES

A. Domestic Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches (mm)
Domestic Hot Water Supply and Recirculation	P-1	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) and larger	1.0 (25) 1.5 (40)

Domestic Hot Water Supply and Recirculation systems with domestic water temperature maintenance cable	P-1	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) and larger	1.0 (25) 1.5 (40)

B. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPE	INSULATION THICKNESS inches (mm)
Domestic Hot Water Storage Tanks	E-1	1.5 (40)

END OF SECTION 220700

SECTION 220800 – COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plumbing commissioning description.
2. Plumbing commissioning responsibilities.

1.2 COMMISSIONING DESCRIPTION

A. Plumbing commissioning process includes the following tasks:

1. Testing and startup of plumbing equipment and systems.
2. Equipment and system verification checks.
3. Assistance in functional performance testing to verify testing and balancing, and equipment and system performance.
4. Provide qualified personnel to assist in commissioning tests, including seasonal testing.
5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
7. Provide operation and maintenance information, list of PM tasks, recommended frequency, any instructions or diagrams needed to do the maintenance task, and record drawings to Commissioning Authority for review verification and organization, prior to distribution. Provide a detailed list of any spare parts, consumables, or special tools that may be needed for long-term maintenance.
8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
9. Provide training for systems specified in this Section with coordination by Commissioning Authority.

B. Equipment and Systems to Be Commissioned:

1. New plumbing systems that were installed under this Contract.
2. Existing plumbing systems that were modified, adjusted, upgraded, or affected by the work performed under this Contract.

C. The following is a partial list of equipment that may be included in this plumbing Commissioning:

1. Booster Pump Systems
2. Recirculation Pumps.
3. Domestic Water Boilers.

4. Domestic Water Heaters.
5. Piping systems.
6. Variable frequency drives.
7. Pressure regulating valves.
8. Circuit setting valves.
9. Testing, Adjusting and Balancing work.

1.3 ACTION SUBMITTALS

A. Draft Forms: Submit draft of system verification form and functional performance test checklist tailored to the project specifics of this contract.

B. Certificate of Readiness: Signed by the contractor, certifying that the plumbing systems, assemblies, equipment, and associated controls are ready for testing.

C. Commissioning Reports:

1. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified. Use AABC forms as guidelines.
2. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.

D. Certificate of Completion: Certifying that the installation, prestart checklists, and startup procedures on all equipment in scope has been completed.

E. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning. Commissioning Agent is to work with contractors on the installation progress and is ultimately responsible for ensuring that the Contractor has accurately updated Record Documents to as built conditions. Commissioning Agent shall notify CAWCD in the event commissioning necessitates changes in the project record drawings.

F. Operation and Maintenance Data: Commissioning Agent to work with Contractor and TAB Contractor and provide final Plumbing Commissioning package with the final O&M Documents submitted to CAWCD. Provide a list of any ‘as left’ setpoints and other similar metrics if they aren’t already provided elsewhere or in the OEM manuals.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ACG, ASHRAE Guideline 1, NEBB, or TABB requirements. Forms to be approved by engineer.

1.5 QUALIFICATIONS

A. Commissioning Authority: A certified commissioning authority (CxA) by the AABC Commissioning Group (ACG) or approved by CAWCD.

1.6 COMMISSIONING RESPONSIBILITIES

A. General Contractor Commissioning Responsibilities

1. Retain services for an independent qualified 3rd party Commissioning Authority. CAWCD to provide approval of Commissioning Agency selected prior to GMP. CAWCD retains the right to hire the 3rd party Commissioning Authority.
2. Provide CAWCD a schedule of commissioning activities and meetings including (but not limited to) the items outlined in Article 1.8.
3. Delivery of plans, submittals, system manuals, and any other equipment-related information for the Commissioning Authority to review prior to field commissioning.

B. Equipment or System Installer Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Ensure temperature controls installer performs assigned commissioning responsibilities as specified below.
3. Ensure testing, adjusting, and balancing agency performs assigned commissioning responsibilities as specified.
4. Provide instructions and demonstrations for CAWCD's personnel.
5. Ensure subcontractors perform assigned commissioning responsibilities.
6. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
7. Develop startup and initial checkout plan using manufacturer’s startup procedures and functional performance checklists for equipment and systems to be commissioned.
8. During verification check and startup process, execute plumbing related portions of checklists for equipment and systems to be commissioned.
9. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
10. Provide manufacturer’s representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.
11. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
12. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
13. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
14. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
15. Provide factory supervised startup services for equipment and systems. Coordinate work with manufacturer and Commissioning Authority.
16. Perform verification checks and startup on equipment and systems as specified. Provide report showing correlation between digital temperature and pressure readings at the same point on the piping system and thermostats.
17. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.

18. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
19. Conduct plumbing system orientation and inspection.

1.7 COMMISSIONING MEETINGS

A. Coordinate all commissioning meetings and progress commissioning meetings with the General Contractor, Plumbing Contractor, and CAWCD.

1.8 SCHEDULING

A. Commissioning Agent to attend pre-installation meetings prior to any plumbing work being performed. Contractor should have Commissioning Agent under contract prior to any plumbing installations.

B. Prepare schedule indicating anticipated start dates for the following:

1. Piping system pressure testing.
2. Piping system flushing and cleaning.
3. Equipment and system startups.
4. Testing, adjusting, and balancing.
5. Plumbing system orientation and inspections.
6. Operation and maintenance manual submittals.
7. Training sessions. Provide two weeks' notice of training sessions for CAWCD staff.

1.9 COORDINATION

A. Notify CAWCD Project Engineer and Project Manager a minimum of four weeks in advance of the following:

1. Scheduled equipment and system startups.
2. Scheduled automatic temperature control system checkout.
3. Scheduled start of testing, adjusting, and balancing work.

B. Coordinate programming of automatic temperature control system with construction and commissioning schedules.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

B. Certify that plumbing instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and all systems are set to and maintaining set points as required by the design documents.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.2 INSTALLATION

A. Install additional balancing valves, access doors, test ports, and pressure and temperature taps required to meet performance requirements.

B. Place plumbing systems and equipment into full operation and continue operation during each working day of commissioning.

C. Install replacement sheaves and belts to obtain system performance, as requested by Commissioning Authority.

3.3 FIELD TESTS AND INSPECTIONS

A. Be responsible to participate in initial test of systems required to demonstrate performance.

B. Occupancy Sensitive Functional Performance Tests:

1. Test equipment and systems affected by occupancy variations at minimum and peak demands to observe system performance.
2. Participate in testing delayed beyond Final Completion to test performance with actual occupancy conditions.

END OF SECTION 220800

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings - domestic water.
2. Piping joining materials - domestic water.
3. Encasement for piping.
4. Transition fittings - domestic water.
5. Dielectric fittings - domestic water.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit data on pipe materials and fittings. Submit manufacturer's catalog information.

B. Shop Drawings (SD):

1. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

C. Quality Control Reports (QCR): Welders' Certificate; Compliance with AWS B2.1. and Compliance with ASME Section IX.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code, as applicable for installation of piping systems and ASME Section IX for welding materials and procedures.

1.4 QUALIFICATIONS

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

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

B. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

C. Piping shall be stored and handled in a safe and secure manner to prevent damage from equipment, traffic, theft, and vandalism.

1.6 FIELD MEASUREMENTS

A. Verify all field measurements prior to fabrication.

1.7 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by CAWCD or others unless permitted under the following conditions and then only after arranging to provide temporary water service in accordance with requirements indicated:

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 PIPING MATERIALS

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

2.3 COPPER TUBE AND FITTINGS - DOMESTIC WATER

A. Drawn-Temper Copper Tube: ASTM B88, Type K.

B. Annealed-Temper Copper Tube: ASTM B88, Type K.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than NPS 4.

F. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than NPS 4.

G. Wrought Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4.

H. Copper-Tube, Mechanically Formed Tee Fitting - Domestic Water: For forming T-branch on copper water tube.

1. Description: Tee formed in copper tube in accordance with ASTM F2014.

I. Pressure-Seal-Joint Fittings, Copper or Bronze - Domestic Water:

1. Source Limitations: Obtain pressure-seal-joint fittings, copper or bronze, from single manufacturer.
2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200 psig working pressure rating at 250 deg F.

2.4 PIPING JOINING MATERIALS - DOMESTIC WATER

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, ASME B16.21 compliant, nonmetallic and asbestos free unless otherwise indicated.

a. Thickness: Minimum 3/32-inch thick for 1-inch pipe and smaller and minimum 1/8-inch thick for pipe larger than 1-inch.

2. Full-face or ring type unless otherwise indicated.

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

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

D. Flux: ASTM B813, water flushable.

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

2.5 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105/A21.5.

B. Form: Sheet or tube.

C. Color: Black or natural.

2.6 TRANSITION FITTINGS - DOMESTIC WATER

A. General Requirements:

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

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

C. Sleeve-Type Transition Couplings - Domestic Water: AWWA C219.

D. Plastic-to-Metal Transition Fittings - Domestic Water:

1. Description:

a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions - Domestic Water:

1. Description:

a. CPVC or PVC four-part union.
b. Brass threaded end.
c. Solvent-cement-joint or threaded plastic end.
d. Rubber O-ring.
e. Union nut.

2.7 DIELECTRIC FITTINGS - DOMESTIC WATER

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

B. Dielectric Unions - Domestic Water:

1. Standard: ASSE 1079.
2. Pressure Rating: 125 psig minimum at 180 deg F or as indicated on Project Drawings.

3. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges - Domestic Water:

1. Standard: ASSE 1079.
2. Factory-fabricated, bolted, companion-flange assembly.
3. Pressure Rating: 125 psig minimum at 180 deg F or as indicated on Project Drawings.
4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits - Domestic Water:

1. Nonconducting materials for field assembly of companion flanges.
2. Pressure Rating: 150 psig or as indicated on Project Drawings.
3. Gasket: Phenolic, Temperature Rating: 225 deg F.
4. Bolt Sleeves: Phenolic or polyethylene.
5. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples - Domestic Water:

1. Standard: IAPMO PS 66.
2. Electroplated steel nipple complying with ASTM F1545.
3. Pressure Rating and Temperature: 300 psig at 225 deg F.
4. End Connections: Male threaded or grooved.
5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

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

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

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

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

1. Annealed-temper copper tube, ASTM B88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger is to be the following:

1. Annealed-temper copper tube, ASTM B88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

F. Under-building-slab, domestic water piping, NPS 2 and smaller is to be the following:

1. Drawn-temper or annealed-temper copper tube, ASTM B88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

G. Aboveground domestic water piping, NPS 2 and smaller is to be the following:

1. Drawn-temper copper tube, ASTM B88, Type K; cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. Drawn-temper copper tube, ASTM B88, Type K; copper pressure-seal-joint fittings; and pressure-sealed joints.

H. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 is to be the following:

1. Drawn-temper copper tube, ASTM B88, Type K; cast- or wrought-copper, solder-joint fittings; and brazed joints.
2. Drawn-temper copper tube, ASTM B88, Type K; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Drawn-temper copper tube, ASTM B88, Type K; grooved-joint, copper-tube appurtenances; and grooved joints.

I. Aboveground domestic water piping, NPS 5 to NPS 8, is to be the following:

1. Drawn-temper copper tube, ASTM B88, Type K; cast- or wrought-copper, solder-joint fittings; and brazed joints.
2. Drawn-temper copper tube, ASTM B88, Type K; grooved-joint, copper-tube appurtenances; and grooved joints.

3.2 INSTALLATION OF PIPING

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

B. Install copper tubing under building slab in accordance with CDA's "Copper Tube Handbook."

C. Install underground copper tube in PE encasement in accordance with ASTM A674 or AWWA C105/A21.5.

D. Install valves in accordance with Section 220523 "General-Duty Valves for Plumbing Piping."

E. Where indicated on Project Drawings, install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

F. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

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

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

I. 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.

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

K. Install piping to permit valve servicing.

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

M. Install piping free of sags and bends.

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

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

P. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220500 "Common Work Results for Plumbing."

Q. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."

R. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Section 220500 "Common Work Results for Plumbing."

S. Install a pressure-temperature test plug (P/T port) adjacent to each pressure gauge and thermometer.

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

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

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

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

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

E. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.

F. Extruded-Tee Connections: Form tee in copper tube in accordance with ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

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

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

3.4 INSTALLATION OF TRANSITION FITTINGS

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

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

3.5 INSTALLATION OF DIELECTRIC FITTINGS

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

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

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

3.7 PIPING CONNECTIONS

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

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

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

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

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

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

3.9 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system in accordance with either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

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

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

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

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

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

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

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

    1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after installation and before setting fixtures.
    2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

    a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
    b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
    c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
    d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
    e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
    f. Prepare reports for tests and for corrective action required.

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

C. Prepare test and inspection reports.

END OF SECTION 221116

SECTION 221119 – DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Vacuum breakers
2. Strainers
3. Unions
4. Flanges
5. Flow Control Valves
6. Backflow Preventers
7. Hose Bibbs
8. Hydrants
9. Recessed Valve Boxes
10. Water Hammer Arrestors
11. Thermostatic Mixing Valves
12. Drain valves
13. Air vents

1.2 PERFORMANCE REQUIREMENTS

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

1.3 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit manufacturer's catalog information with valve data and ratings for each service.

B. Manufacturer's Installation Instructions:

1. Submit hanging and support methods, joining procedures.

C. Coordination Drawings:

1. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

D. Operation and Maintenance Data:

1. Include in final O&M Manuals provided to CAWCD.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:

1. Comply with NSF 14, Plastics Piping Components and Related Materials, for plastic domestic water piping components.
2. Comply with NSF 61, Drinking Water System Components – Health Effects; Sections 1 through 9.

1.5 QUALIFICATIONS

A. Manufacturer:

1. Company specializing in manufacturing Products specified in this section with five years documented experience.
2. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare specialties for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Provide temporary protective coating on cast iron and steel valves if required.

B. Use the following precautions during storage:

1. Store specialties indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store specialties off the ground in watertight enclosures.

1.7 WARRANTY

A. Furnish five-year manufacturer warranty for piping specialties. Warranty date shall begin at date of start-up.

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

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

1. Manufacturers:

a. Conbraco Industries, Inc.
b. FEBCO; SPX Valves & Controls.
c. Watts Industries, Inc.; Water Products Div.
d. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers:

a. Conbraco Industries, Inc.
b. MIFAB, Inc.
c. Watts Industries, Inc.; Water Products Div.
d. Woodford Manufacturing Company.
e. Zurn Plumbing Products Group.

2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or Rough bronze.

C. Pressure Vacuum Breakers:

1. Manufacturers:

a. Conbraco Industries, Inc.
b. FEBCO; SPX Valves & Controls.
c. Watts Industries, Inc.; Water Products Div.
d. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Accessories:

a. Valves: Ball type, on inlet.

2.2 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 and Smaller: 0.020 inch.
    b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
    c. Strainers NPS 5 and Larger: 0.10 inch.

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

2.3 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:

1. Copper Piping: Class 150, bronze unions with soldered joints.
2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches and Larger:

1. Copper Piping: Class 150, slip-on bronze flanges.
2. Gaskets: 1/16-inch-thick preformed neoprene gaskets.

2.4 FLOW CONTROL VALVES

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

1. Armstrong Pumps, Inc.
2. Bell & Gossett Domestic Pump; a division of ITT Industries.
3. Griswold Controls.
4. Taco.
5. Tour & Andersson; available through Victaulic Company.
6. Substitutions: Not permitted.

B. Construction: Class 125, Brass or bronze body, multi-turn globe valve with union on inlet and outlet, temperature and pressure test plug on inlet and outlet.

C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 5 psi.

2.5 BACKFLOW PREVENTERS

A. Manufacturers:

1. Ames Fire & Waterworks; A Watts Water Technologies Company
2. Apollo Valves; a part of Aalberts Integrated Piping Systems
3. FEBCO; A WATTS Brand
4. WATTS; A Watts Water Technologies Company
5. Zurn Industries, LLC
6. Substitutions: Not permitted.

B. Reduced-Pressure-Principal Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle third of flow range.
4. Body: Bronze or stainless steel for NPS 2 and smaller; ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Accessories:

    a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check, Backflow-Prevention Assemblies:

1. Standard: ASSE 1015.
2. Operation: Continuous-pressure applications unless otherwise indicated.
3. Pressure Loss: 5 psig maximum, through middle third of flow range.
4. Body: Bronze or stainless steel for NPS 2 and smaller; ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Accessories:

    a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

2.6 HOSE BIBS

A. Manufacturers:

1. JR Smith.

2. Watts.
3. Wilkins.
4. Substitutions: Permitted with CAWCD approval.

B. Interior: Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed with lock shield and removable key, integral vacuum breaker in conformance with ASSE 1011.

2.7 HYDRANTS

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

1. Chicago.
2. MIFAB, Inc.
3. Prier Product, Inc.
4. Smith, Jay R. Mfg. Co.
5. Watts Drainage Products Inc.
6. Woodford Manufacturing Company.
7. Zurn.
8. Substitutions: Not permitted.

B. Wall Hydrant: ASSE 1019; non-freeze, self-draining type with polished bronze lockable recessed box hose thread spout, locks shield and removable key, and integral vacuum breaker.

2.8 RECESSED VALVE BOX

A. Refrigerator: Plastic preformed rough-in box with brass valves with wheel handle slip in finishing cover.

2.9 WATER HAMMER ARRESTORS

A. Manufacturers:

1. MIFAB, Inc.
2. PPP Inc.
3. Sioux Chief Manufacturing Company, Inc.
4. Smith, Jay R. Mfg. Co.
5. Watts Drainage Products Inc.
6. Zurn.
7. Substitutions: Not permitted.

B. ASSE 1010; stainless steel or copper construction, bellows or piston type sized according to PDI WH-201.

C. Pre-charged suitable for operation in temperature range 34 to 250 degrees F and maximum 150 psi working pressure.

2.10 THERMOSTATIC MIXING VALVES

A. Manufacturers:

1. Bradley.
2. Lawler Manufacturing Company, Inc.
3. Powers.
4. Symmons Industries, Inc.
5. Wilkins.
6. Substitutions: Not permitted.

B. Valve: Chrome-plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment. Conform to ASSE 1070 to temper water to maximum 110 degrees F.

C. Accessories:

1. Check valve on inlets.
2. Volume control shut-off valve on outlet.
3. Stem thermometer on outlet.
4. Strainer stop checks on inlets.

D. Cabinet: 16 gage stainless steel, for recessed mounting with keyed lock.

2.11 DIAPHRAGM-TYPE COMPRESSION TANKS

A. Construction: Welded steel, tested and stamped according to ASME Section VIII; supplied with National Board Form U-1, rated for working pressure of 125 psig (860 kPa), with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.

B. Accessories: Pressure gage and air-charging fitting, tank drain; pre-charge to match the incoming water pressure.

2.12 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

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

2.13 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating:125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Inlet and Vent Outlet End Connections: Threaded.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Section 220500 for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
2. Do not install bypass piping around backflow preventers.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install Y-pattern strainers for water on supply side of each control valve, water pressure- reducing valve, solenoid valve, and pump.

E. Install air vents at high points of water piping. Install drain piping and discharge to floor drain.

3.2 CONNECTIONS

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

B. Ground equipment according to Section 260526 “Grounding and Bonding for Electrical Systems”.

C. Connect wiring according to Section 260519 “Low-Voltage Conductors and Cables”.

END OF SECTION 221119

SECTION 221123 – DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Hot water circulating pumps
2. Domestic water pressure booster systems

1.2 ACTION SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with Section 013300 “Submittal Procedures”.

B. Manufacturer's Literature and Data including full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.

1. Pump:

a. Manufacturer and model.
b. Operating speed.
c. Capacity.
d. Characteristic performance curves.

2. Motor:

a. Manufacturer, frame and type.
b. Speed.
c. Current Characteristics.
d. Efficiency.

3. Tank:

a. Manufacturer and model.
b. Capacity

4. Drive: Information in accordance with Division 26.

C. Certificate of shop test for domestic water booster system. Provide certified performance curves.

D. Certified copies of all the factory and construction site test data sheets and reports.

E. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:

1. Include complete list indicating all components of the systems.
2. Include complete diagrams of the internal wiring for each item of equipment.
3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.

F. Completed System Readiness Checklist provided by the CxA (Commissioning Authority) and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 220800 “Commissioning of Plumbing”.

G. Submit training plans and instructor qualifications in accordance with the requirements of Section 220800 “Commissioning of Plumbing”.

1.3 QUALITY ASSURANCE

A. General:

1. UL Compliance: Comply with UL 778 for motor-operated water pumps.
2. Design Criteria:

    a. Pump sizes, capacities, pressures, operating characteristics and efficiency shall be as scheduled.
    b. Head-capacity curves shall slope up to maximum head at shut-off. Select pumps near the midrange of the curve, and near the point of maximum efficiency, without approaching the pump curve end point and possible cavitation and unstable operation. Select pumps for open systems so that required net positive suction head (NPSHR) does not exceed the net positive head available (NPSHA).
    c. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity curve, including in a parallel or series pumping installation with one pump in operation.
    d. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.
    e. Furnish each pump and motor with a nameplate giving the manufacturers name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed and full load current and motor efficiency.
    f. Test all pumps before shipment. The manufacturer shall certify all pump ratings.
    g. After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow at actual pumping head, as installed.

B. Domestic Water Pressure Booster System:

1. Components shall be furnished by a single manufacturer and the system shall be the standard cataloged product of the manufacturer.
2. Shop Test: Water booster unit and its component parts shall undergo a thorough electric and hydraulic operating test prior to shipment. Tests shall include a system operating flow test from zero to 100 percent of design flow rate under specified

suction and system pressure conditions. Certified performance curves shall be furnished.

1.4 AS-BUILT DOCUMENTATION

A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.

B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the CAWCD will be required to employ shall be inserted into the As-Built documentation.

C. The installing contractor shall maintain as-built drawings of each completed phase for verification and shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 2017. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

D. Certification documentation shall be provided to CAWCD's Representative 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Material or equipment containing a weighted average of greater than 0.25 percent lead shall be prohibited in any potable water system intended for human consumption and shall be certified in accordance with NSF 61 or NSF 372.

2.2 DOMESTIC WATER PRESSURE BOOSTER SYSTEM

A. General: Provide a factory prefabricated, prewired and pretested multi-stage pumping system including variable speed drive motors, pressure regulating valves with integral check valves, pressure transducers, vibration pads, emergency switches, duplex flow switches, power and control panels, suction and discharge manifolds, butterfly isolation

valves, ball drain valves, bypass loops with appropriate valves and check valves, low pressure cut-off switches, hydropneumatic tanks and accessories. All components shall be furnished by a single manufacturer and the system shall be the standard cataloged product of the manufacturer. All components shall be factory installed on a common structural steel skid and shall be completely tested in the factory before shipment. Manufacturer shall assume “unit responsibility” to ensure that all components effectively interface to execute the operation of the designed system.

B. System Operation and Configuration:

1. System shall automatically maintain constant system pressure of 70 psig at the outlet of the pressure control valve and hydropneumatic tank check valve at all times. Suction pressure varies from 5 psig to 0 psig. The multi-stage pumping system shall include two pumps.
2. Duplex pump systems shall include both pumps sized for 75 percent of the total capacity.

C. Centrifugal Pump: Pumps shall be single stage, in-line pump with variable speed drive motor, low pressure cut-off switches and bypass loops with ball, gate, and check valves as indicated on the Contract Drawings.

1. Impellers: ASTM B584 Cast bronze, radially or vertically split keyed to shaft and secured by a locking cap-screw. Each impeller shall be statically and dynamically balanced prior to assembly in pump casing. Provide replaceable bronze casing wear rings.
2. Pump shaft: Steel, with replaceable bronze shaft sleeve completely covering the wetted area of the shaft under the seal.
3. Lubrication: Water lubricated type pump.
4. Pump Casing: ASTM A48/A48M CL20 Cast iron suitable for 175 psig. Pump volute shall be supplied with vent and drain tappings. Connections shall be female NPT. The casing shall be O-ring sealed to the seal housing.
5. Seal: Mechanical general-purpose type, with sleeve mounting. Seal shall be rated at 175 psig maximum.
6. Adjustable Spacer Coupling: Removable type required so that pump seal can be replaced without disturbing motor.
7. Motor: Solid shaft motors balanced to 0.0085-inch vibration amplitude shall be operated at any point on the pump head curve without overloading the motor. Conform to NEMA Type 2.

D. Vertical Multistage Pump: Pumps shall be vertical multistage short-coupled pumps with variable speed drive motor, low pressure cut-off switches and bypass loops with ball, butterfly, check valves as indicated on the Contract Drawings.

1. Impellers: Cast bronze, mixed flow enclosed type.
2. Balancing of Impellers: Each impeller shall be statically and dynamically balanced prior to assembly in pump casing.
3. Pump shaft: Stainless steel Type 416.
4. Lubrication: Water lubricated type pump.
5. Pump Bowls: Cast Iron, stainless steel or bronze flanged and bolted.
6. Pump Bearings: Bronze, radial type.
7. Pump Head: Fabricated steel with continuous bypass for low seal pressure. Cast iron heads are prohibited. Pump head shall be lined same as pump barrel.

8. Seal: Mechanical general-purpose type, with sleeve mounting. Seal shall be rated at 175 psig maximum.
9. Adjustable Spacer Coupling: Removable type required so that pump seal can be replaced without disturbing motor.
10. Motor: Solid shaft motors balanced to 0.0085-inch vibration amplitude shall be operated at any point on the pump head curve without overloading the motor. Conform to NEMA Type 2.
11. Pump Barrel: Schedule 40 steel pipe with two-coat "baked" internal lining to meet the potable water requirements of U.S. Food and Drug Administration. Bio-based materials shall be utilized when possible. Unlined pump barrels are prohibited. Provide drain tapping.

E. Pressure Regulating Valves: System pressure shall be maintained by pilot-operated, diaphragm type pressure regulating valves, rated at 300 psig minimum, one for each pump. Valves shall be piloted to control system pressure and to cause the valve to act as a non-slam check valve. Pilot shall be rated at 175 psig minimum.

F. Hydropneumatic Tank: Bladder type, hydropneumatic, designed and constructed in accordance with requirements of the ASME Pressure Vessel Code and stamped with appropriate symbol. Tank shall include pre-pressurized, sealed-in air cushion which shall accommodate pressure increases and expanded water volumes in the tank. Tank shall include butyl rubber or poly-propylene liner in lower, or water side of chamber. Minimum working pressure of tank shall be 175 psig. Unit shall be designed and manufactured for domestic water applications. Insulate tank as specified. Check valve at hydropneumatic tank shall include small orifice for undue loading.

G. Power and Control Panel: Class "A" shadow box double NEMA 1 enclosure, UL labeled, bonderized double prime coated with baked enamel finish:

1. Fused disconnect switches with external operating handles.
2. Magnetic contactor for each motor with HOA switch.
3. Door interlock.
4. Thermal overload protection relay for each motor, three leg type.
5. Running light for each motor.
6. Power light for each motor.
7. Control transformer, switch, circuit breaker, light.
8. Lead pump failure protection.

H. Motor and Starter: Maximum 104 degrees F ambient temperature rise, drip-proof type motor, ball bearings, voltage and phase as shown in schedule on Electrical drawings, conforming to NEMA Type 4. Motor shall be of such capacity that brake horsepower required by driven equipment at normal rated capacity will not exceed nameplate rating of the motor. Refer to Section 220513 “Common Motor Requirements for Plumbing Equipment”. Provide each motor with automatic, fully enclosed, magnetic starter of type specified in Section 262913 “Variable Frequency Motor Controllers”.

I. Instrumentation: All instrumentation shall be factory installed and shall include the following 4-1/2-inch dial gauges with shut-off cock.

1. Pump pressure gauge for each pump.
2. System pressure gauge.
3. Suction pressure gauge.

J. Operating and Emergency Controls:

1. The pump station shall receive a 4-20mA signal from each pressure transducer, as provided by the pumping station manufacturer. A pressure transducer signal shall be provided for each pump controller. The differential pressure transducers shall monitor system discharge pressure versus suction line pressure and provide an analog signal 4-20mA to the pump control software, and allow the variable speed pump controller, to provide a variable Volts/Hz output to the motor. Once the pressure drops below the set system pressure, the pump shall start and provide system pressure (as determined by the station operator or program), if this pressure cannot be maintained by one pump, the next pump in sequence shall operate in a //lead/lag// //stand-by// capacity to provide the extra flow and pressure automatically without the use of additional panels or alternators. The sequence of the pumps shall be field adjustable, and completely automatic without additional panels or alternator controls. The variable speed pump controller shall be completely integrated with the VFD. Special type motors shall not be allowed. Refer to Section 220513 “Common Motor Requirements for Plumbing Equipment”. Pump assignments shall alternate as described below. All program settings shall be based on centrifugal pump language and centrifugal pumps. Program settings shall be field adjustable to provide onsite adjustments. When the system experiences low demand, the variable speed pump controllers shall reduce the speed of each pump, until demand has stopped. Pump controllers shall stop each pump at zero demand, without the use of external switches or controls.
2. The pumping system includes multiple pumps as indicated above. In two-pump systems, the first (lead) pump operates initially, and the second pump serves as a lag pump capable of operating concurrently with the lead pump to add capacity when needed. The second pump also acts as a stand-by pump at lower demands, ready for operation if the lead pump is taken out of service. Pump assignments shall alternate to automatically equalize the run time in similarly sized pumps, which excludes uniquely sized lead pumps.
3. The pump logic controller shall provide the following standard user-selectable features:

    a. Low Suction Pressure Alarm and Cut Out
    b. High Suction Pressure Alarm and Cut Out
    c. Low System Pressure Alarm
    d. High System Pressure Alarm and Cut Out
    e. High Temperature Alarm and Cut Out
    f. Low Level Alarm and Cut Out
    g. No-Flow Shut Down
    h. Audible/Visible alarm with push to silence feature
    i. Overload Failure Alarm
    j. Pump Failure Alarm
    k. Pump operating order assignments
    l. Minimum run timers to prevent short cycle operation.

4. Provide auxiliary contacts for remote communication with the BAS, including the following input/output points:

    a. Domestic water supply pressure (analog input to BAS)
    b. Alarm condition activated (binary input to BAS)

c. Run status of lead pump (binary input to BAS)
d. Run status of lag pump (binary input to BAS)

K. Factory Test: The booster system and its component parts shall undergo a complete operation flow test from zero to 100 percent design flow rate under the specified suction and net system pressure conditions. The system certification shall include copies of the test and test data as performed in the factory prior to shipment. Performance test certifications should be placed inside the system control panel and two extra copies shall be provided to the CAWCD's Representative with the installation manual.

2.3 HOT WATER CIRCULATING PUMPS

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

1. Armstrong Pumps Inc.
2. Grundfos Pumps Corp.
3. TACO.
4. Substitutions: Not permitted.

B. Type: Horizontal shaft, single stage, direct connected with multiple speed wet rotor motor for in-line mounting, for 140 psig maximum working pressure, 230 degrees F maximum water temperature.

C. Casing: Bronze with flanged pump connections.

D. Impeller, Shaft, Rotor: Stainless Steel.

E. Bearings: Metal Impregnated carbon (graphite) and ceramic.

F. Motor: Impedance protected, single speed.

PART 3 - EXECUTION

3.1 STARTUP AND TESTING

A. Make tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

B. System Test: After installation is completed provide an operational test of the completed system including flow rates, pressure compliance, alarms and all control functions.

C. When any defects are detected, correct defects and repeat test at no additional cost or time to the CAWCD.

D. The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the CAWCD's Representative and CxA. Contractor shall provide a minimum of 10 working days prior to startup and testing.

E. Pumps:

1. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
2. Install long-radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve, balancing valve, and shut-off valve on pump discharge.
3. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump so no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches (100 mm) and larger.
4. Provide air cock and drain connection on horizontal pump casings.
5. Provide drains for bases and seals.
6. Check, align, and certify alignment of base mounted pumps prior to start-up.

3.2 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 220800 "Commissioning of Plumbing".

B. Components provided under this section of the specification will be tested as part of a larger system.

3.3 DEMONSTRATION AND TRAINING

A. Provide services of manufacturer's technical representative for two hours to instruct CAWCD's Personnel in operation and maintenance of the system.

B. Submit training plans and instructor qualifications in accordance with the requirements of Section 220800 "Commissioning of Plumbing".

END OF SECTION 221123

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Copper tube and fittings.
4. ABS pipe and fittings.
5. PVC pipe and fittings.
6. Specialty pipe fittings.
7. Encasement for underground metal piping.

B. ACTION SUBMITTALS

1. Product Data (PD):

a. Submit data on pipe materials and fittings. Submit manufacturer's catalog information.

2. Shop Drawings (SD):

a. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

3. Quality Control Reports (QCR): Welders’ Certificate; Compliance with AWS B2.1. and Compliance with ASME Section IX.

C. QUALITY ASSURANCE

1. Perform Work in accordance with ASME B31.9 code, as applicable for installation of piping systems and ASME Section IX for welding materials and procedures.

D. QUALIFICATIONS

1. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
2. Installer: Company specializing in performing work of this section with minimum five years documented experience.

E. DELIVERY, STORAGE, AND HANDLING

1. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

2. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
3. Piping shall be stored and handled in a safe and secure manner to prevent damage from equipment, traffic, theft, and vandalism.

F. FIELD MEASUREMENTS

1. Verify all field measurements prior to fabrication.

G. FIELD CONDITIONS

1. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by CAWCD or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

a. Notify CAWCD no fewer than two days in advance of proposed interruption of water service.
b. Do not interrupt water service without CAWCD's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10 ft. head of water.
2. Force-Main Waste Piping: 100 psig or as indicated on Project Drawings.

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

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

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings:

1. Marked with CISPI collective trademark.
2. ASTM A74, service cast iron.

B. Gaskets: ASTM C564, rubber.

C. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings:

1. Marked with CISPI collective trademark.
2. ASTM A888 or CISPI 301.

B. Single-Stack Aerator Fittings: ASME B16.45, hubless, cast-iron aerator and deaerator drainage fittings.

C. CISPI, Hubless-Piping Couplings:

1. Standards: ASTM C1277 and CISPI 310.
2. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:

1. Standards: ASTM C1277 and ASTM C1540.
2. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.5 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B88, Type L and Type M, water tube, drawn temper.

D. Soft Copper Tube: ASTM B88, Type L, water tube, annealed temper.

E. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.6 ABS PIPE AND FITTINGS

A. NSF Marking: Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

B. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.

C. ABS Socket Fittings: ASTM D2661, made in accordance with ASTM D3311, drain, waste, and vent patterns.

D. Solvent Cement: ASTM D2235.

1. Solvent cement shall have a VOC content of 325 g/L or less.

2.7 PVC PIPE AND FITTINGS

A. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.

B. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.

C. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F656.

1. Adhesive primer shall have a VOC content of 550 g/L or less.

E. Solvent Cement: ASTM D2564.

1. Solvent cement shall have a VOC content of 510 g/L or less.

2.8 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Non-pressure Transition Couplings:

a. Standard: ASTM C1173.
b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
c. End Connections: Same size as and compatible with pipes to be joined.
d. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.

3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.

4. Shielded, Non-pressure Transition Couplings:

   a. Standard: ASTM C1460.
   b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   c. End Connections: Same size as and compatible with pipes to be joined.

5. Pressure Transition Couplings:

   a. Standard: AWWA C219.
   b. Description: Metal sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   c. Center-Sleeve Material: Manufacturer's standard.
   d. Gasket Material: Natural or synthetic rubber.
   e. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

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

   a. Description:

      1) Standard: ASSE 1079.
      2) Pressure Rating: 125 psig minimum at 180 deg F or as indicated on Project Drawings.
      3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

   a. Description:

      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: 125 psig minimum at 180 deg F or as indicated on Project Drawings.
      4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

   a. Description:

      1) Nonconducting materials for field assembly of companion flanges.
      2) Pressure Rating: 150 psig or as indicated on Project Drawings.
      3) Gasket: Neoprene or phenolic.
      4) Bolt Sleeves: Phenolic or polyethylene.

5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

a. Description:

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

2.9 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A674 or AWWA C105/A 21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify excavations are to required grade, dry, and not over-excavated.

B. Verify trenches are ready to receive piping.

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

    1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
    2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back-to-back or side by side with common drain pipe.

        a. Straight tees, elbows, and crosses may be used on vent lines.

    3. Do not change direction of flow more than 90 degrees.
    4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

        a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.

    1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
    2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
    3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated on Project Drawings:

    1. Building Sanitary Waste: Two percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
    2. Horizontal Sanitary Waste Piping: Two percent downward in direction of flow.
    3. Vent Piping: One percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

    1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.

N. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."

O. Install aboveground ABS piping in accordance with ASTM D2661.

P. Install aboveground PVC piping in accordance with ASTM D2665.

Q. Install underground ABS and PVC piping in accordance with ASTM D2321.

R. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

S. Install underground, copper, force-main tubing in accordance with CDA's "Copper Tube Handbook."

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

T. Install force mains at elevations indicated.

U. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping.
2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

    a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.

3. Install drains in sanitary waste gravity-flow piping.

V. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

W. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Result for Plumbing."

X. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Result for Plumbing."

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

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Result for Plumbing."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints:

1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

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

E. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

F. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

H. Plastic, Non-pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.

I. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Unshielded or shielded, non-pressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

   a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
   b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installation are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated on Project Drawings.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible valve boxes.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

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

3.7 CONNECTIONS

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

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves with cleanout cover flush with floor.
6. Equipment: Connect waste piping as indicated.

    a. Provide shutoff valve if indicated and union for each connection.
    b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections in accordance with the following unless otherwise indicated:

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

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

    a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water.
    b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

    a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

E. Test force-main piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.

a. Isolate test source and allow to stand for four hours.
b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed Plastic Piping: Protect ABS and PVC plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller are to be the following:

1. Service cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings and hubless, single-stack aerator fittings; CISPI hubless-piping couplings; and coupled joints.
3. Copper Type DWV tube, copper drainage fittings, and soldered joints.
4. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: Unshielded or shielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 and larger are to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings and hubless, single-stack aerator fittings; CISPI hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded or shielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 is to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Copper Type DWV tube, copper drainage fittings, and soldered joints.

    a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, Type M; copper pressure fittings; and soldered joints.

4. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: Unshielded or shielded, non-pressure transition couplings.

E. Aboveground, vent piping NPS 5 and larger is to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded or shielded, non-pressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 4 and smaller are to be the following:

1. Service cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints.
3. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded or shielded, non-pressure transition couplings.

G. Underground, soil and waste piping NPS 5 and larger are to be the following:

1. Service, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless piping couplings; coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded or shielded, non-pressure transition couplings.

H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 are to be the following:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.

I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 are to be the following:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

J. Underground sanitary-sewage force mains NPS 4 and smaller are to be the following:

1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
2. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

K. Underground sanitary-sewage force mains NPS 5 and larger are to be the following:

1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
2. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 221316

SECTION 221319.13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor drains.
2. Floor sinks.
3. Trench drains.
4. Channel drainage systems.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit manufacturer’s literature for sanitary drains.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit literature and parts list.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers:

a. Wade; a subsidiary of McWane Inc.
b. WATTS; A Watts Water Technologies Company
c. Zurn Industries, LLC

2. Standard: ASME A112.6.3.
3. Pattern: As indicated on Project Drawings.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.

8. Outlet: Bottom.
9. Backwater Valve: Not required unless indicated otherwise on Project Drawings.
10. Coating on Interior and Exposed Exterior Surfaces: Not required.
11. Sediment Bucket: Not required.
12. Top or Strainer Material: Gray iron, Nickel bronze, or Stainless steel.
13. Top of Body and Strainer Finish: Nickel bronze, Polished bronze, Rough bronze, Stainless steel.
14. Top Shape: Round or Square.
15. Top Loading Classification: Light Duty unless indicated otherwise on Project Drawings.
16. Funnel: Not required.
17. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
18. Trap Pattern: Deep-seal P-trap.
19. Trap Features: Trap-seal primer valve drain connection.

B. Stainless Steel Floor Drains, ASME A112.3.1:

1. Manufacturers:

    a. Wade; a subsidiary of McWane Inc.
    b. WATTS; A Watts Water Technologies Company
    c. Zurn Industries, LLC

2. Outlet: Bottom.
3. Top or Strainer Material: Stainless steel.
4. Top Shape: Round or Square.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Trap Material: Stainless steel.
9. Trap Pattern: Deep-seal P-trap
10. Trap Features: Trap-seal primer valve drain connection.

C. Stainless Steel Floor Drains, ASME A112.6.3:

1. Manufacturers:

    a. Wade; a subsidiary of McWane Inc.
    b. BLÜCHER; A Watts Water Technologies Company
    c. WATTS; A Watts Water Technologies Company
    d. Zurn Industries, LLC

2. Outlet: Bottom.
3. Top or Strainer Material: Stainless steel.
4. Top Shape: Round or Square.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Trap Material: Stainless steel.
9. Trap Pattern: Deep-seal P-trap
10. Trap Features: Trap-seal primer valve drain connection.

2.3 FLOOR SINKS

A. Cast-Iron Floor Sinks:

1. Manufacturers:

    a. Wade; a subsidiary of McWane Inc.
    b. WATTS; A Watts Water Technologies Company
    c. Zurn Industries, LLC

2. Standard: ASME A112.6.7.
3. Pattern: Floor or Funnel floor drain.
4. Body Material: Cast iron.
5. Anchor Flange: Required, with seepage holes.
6. Clamping Device: Required.
7. Outlet: Bottom, no-hub connection.
8. Coating on Interior Surfaces: Acid-resistant enamel.
9. Sediment Bucket: Not required.
10. Internal Strainer: Dome.
11. Internal Strainer Material: Aluminum.
12. Top Grate Material: Cast iron, loose.
13. Top of Body and Grate Finish: Acid-resistant enamel.
14. Top Shape: Square.
15. Top Loading Classification: No traffic.
16. Funnel: Required.

B. Stainless Steel Floor Sinks, ASME A112.6.7:

1. Manufacturers:

    a. Wade; a subsidiary of McWane Inc.
    b. BLÜCHER; A Watts Water Technologies Company
    c. WATTS; A Watts Water Technologies Company
    d. Zurn Industries, LLC

2. Standard: ASME A112.6.7.
3. Pattern: Floor or Funnel floor drain.
4. Body Material: Stainless steel.
5. Anchor Flange: Required, with seepage holes.
6. Clamping Device: Required.
7. Outlet: Bottom, no-hub connection.
8. Sediment Bucket Not required.
9. Internal Strainer Dome.
10. Internal Strainer Material: Stainless steel.
11. Top Grate Material: Stainless steel., loose.
12. Top of Body and Grate Finish: Stainless steel.
13. Top Shape: Square.
14. Top Loading Classification No traffic.
15. Funnel: Required.

2.4 TRENCH DRAINS

A. Trench Drains:

1. Manufacturers:

    a. Wade; a subsidiary of McWane Inc.
    b. WATTS; A Watts Water Technologies Company
    c. Zurn Industries, LLC

2. Standard: ASME A112.6.3 for trench drains.
3. Material: Ductile or gray iron.
4. Flange: Seepage.
5. Clamping Device: Required.
6. Outlet: Bottom, End, or Side as indicated on Project Drawings.
7. Grate Material: Ductile iron or gray iron.
8. Top Loading Classification: Heavy Duty unless indicated otherwise on Project Drawings.
9. Trap Material: Cast iron.
10. Trap Pattern: Standard P-trap.

2.5 CHANNEL DRAINAGE SYSTEMS

A. Stainless Steel Channel Drainage Systems, ASME A112.3.1:

1. Manufacturers:

    a. Wade; a subsidiary of McWane Inc.
    b. BLÜCHER; A Watts Water Technologies Company
    c. WATTS; A Watts Water Technologies Company
    d. Zurn Industries, LLC

2. Description: Modular system of stainless steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Standard: ASME A112.3.1 for trench drains.
4. Channel Sections: Interlocking joint, stainless steel with level invert.

    a. Dimensions: 5.8 inches wide. Include number of units required to form total lengths indicated on Project Drawings.

5. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channels.

    a. Material: Stainless steel.
    b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

6. Covers: Solid stainless steel, of width and thickness that fit recesses in channels, and of lengths indicated on Project Drawings.
7. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.

8. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

B. Stainless Steel Channel Drainage Systems, Non-ASME A112.3.1:

1. Manufacturers:

a. Wade; a subsidiary of McWane Inc.
b. BLÜCHER; A Watts Water Technologies Company
c. WATTS; A Watts Water Technologies Company
d. Zurn Industries, LLC

2. Description: Modular system of stainless steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Channel Sections: Interlocking joint, stainless steel with level invert.

a. Dimensions: 12 inches wide. Include number of units required to form total lengths indicated.

4. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channels.

a. Material: Stainless steel.
b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

5. Covers: Solid Stainless steel, of width and thickness that fit recesses in channels, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install floor drains/sinks at low points of surface areas to be drained. Set grates of drains/sinks flush with finished floor, unless otherwise indicated.

1. Position floor drains/sinks for easy access and maintenance.
2. Set floor drains/sinks below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.

c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains/sinks connected to sanitary building drain, unless otherwise indicated.

B. Install trench drains at low points of surface areas to be drained.

1. Set grates of drains flush with finished surface, unless otherwise indicated.

C. Comply with ASME A112.3.1 for installation of stainless steel channel drainage systems.

1. Install on support devices, so that top will be flush with adjacent surface.

D. Install open drain fittings with top of hub 1 inch above floor.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

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

3.3 LABELING AND IDENTIFYING

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

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319.13

SECTION 221414 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Copper tube and fittings.
5. ABS pipe and fittings.
6. PVC pipe and fittings.
7. Specialty pipe fittings.
8. Encasement for underground metal piping.

B. ACTION SUBMITTALS

1. Product Data (PD):

a. Submit data on pipe materials and fittings. Submit manufacturer's catalog information.

2. Shop Drawings (SD):

a. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

3. Quality Control Reports (QCR): Welders’ Certificate; Compliance with AWS B2.1. and Compliance with ASME Section IX.

C. QUALITY ASSURANCE

1. Perform Work in accordance with ASME B31.9 code, as applicable for installation of piping systems and ASME Section IX for welding materials and procedures.

D. QUALIFICATIONS

1. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
2. Installer: Company specializing in performing work of this section with minimum five years documented experience.

E. DELIVERY, STORAGE, AND HANDLING

1. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

2. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
3. Piping shall be stored and handled in a safe and secure manner to prevent damage from equipment, traffic, theft, and vandalism.

F. FIELD MEASUREMENTS

1. Verify all field measurements prior to fabrication.

G. FIELD CONDITIONS

1. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by CAWCD or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

a. Notify CAWCD no fewer than two days in advance of proposed interruption of service.
b. Do not interrupt storm drainage service without CAWCD's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are to be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: 10 ft. head of water.
2. Storm Drainage, Force-Main Piping: 100 psig or as indicated on Project Drawings.

2.2 2.2. DRAINS (Pumping Plants Only)

A. Overflow Roof Drains: Shall conform with ASME A 112.6.4 and be appropriate for existing conditions and proposed use.

B. Dome type: Zurn Standard Sump Roof Drain with self-locking cast iron dome strainer and 2" high external water dam, or equal from Jay R. Smith or Josam.

C. Anchor Flange and Under-Deck Clamp: As required to set into and secure to precast concrete tee flange. Cast iron including required anchor flanges and clamp ring.

D. Outlet pipe connection: No-Hub or Gasket. Size shall be same as connected conductor.

E. Downspout Nozzle: Zurn Z199 or Jay R. Smith 1770 Downspout Nozzle, nickel bronze or cast bronze body, PVC slip-on or No-Hub connection, including decorative face of wall flange and outlet nozzle. Size shall be same as connected conductor.

2.3 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

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

2.4 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standard: ASTM A74.
3. Class: Service weight cast iron.

B. Gaskets: ASTM C564, rubber.

C. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.5 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standards: ASTM A888 and CISPI 301.

B. Standard, Hubless-Piping Couplings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standards: ASTM C1277 and CISPI 310.
3. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Standard: ASTM C1277 or ASTM C1540.
2. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Hubless-Piping Couplings:

1. Standard: ASTM A1056.
2. Description: Two-piece ASTM A48/A48M, cast-iron housing; stainless steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.6 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A53/A53M, Type E, standard-weight class. Include ends matching joining method.

B. Cast-Iron Drainage Fittings: Galvanized, ASME B16.12, threaded.

C. Steel-Pipe Pressure Fittings:

1. Steel Pipe Nipples: Galvanized, ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: Galvanized, ASME B16.4, Class 125, standard pattern.

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

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:

1. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping:

a. ASTM A536 ductile-iron castings.
b. ASTM A234/A234M forged-steel fittings.

2.7 COPPER TUBE AND FITTINGS

A. Copper Tube:

1. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.
2. Copper Tube, Drawn Temper: ASTM B88, Type L and Type M.
3. Copper Tube, Annealed Temper: ASTM B88, Type L.

B. Copper Fittings:

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
2. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
4. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

a. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
b. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.8 ABS PIPE AND FITTINGS

A. ABS Pipe:

1. NSF Marking: Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
2. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.

B. ABS Socket Fittings:

1. Standard: ASTM D2661, made in accordance with ASTM D3311, drain, waste, and vent patterns.
2. NSF Marking: Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. Solvent Cement: ASTM D2235.

2.9 PVC PIPE AND FITTINGS

A. PVC Pipe:

1. NSF Marking: Comply with NSF 14 for plastic piping components. Include marking with "NSF-dwv" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
2. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.

B. PVC Socket Fittings:

1. Standard: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
2. NSF Marking: Comply with NSF 14 for plastic piping components. Include marking with "NSF-dwv" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. Adhesive Primer: ASTM F656.

1. Adhesive primer shall have a VOC content of 550 g/L or less.

D. Solvent Cement: ASTM D2564.

1. Solvent cement shall have a VOC content of 510 g/L or less.

2.10 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.

3. Unshielded, Non-pressure Transition Couplings:

    a. Standard: ASTM C1173.
    b. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    c. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C564 rubber.
        2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.
        3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.

4. Shielded, Non-pressure Transition Couplings:

    a. Standard: ASTM C1460.
    b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
    c. End Connections: Same size as and compatible with pipes to be joined.

5. Pressure Transition Couplings:

    a. Standard: AWWA C219.
    b. Description: Metal, sleeve-type couplings same size as pipes to be joined, and with pressure rating at least equal to and ends compatible with pipes to be joined.
    c. Center-Sleeve Material: Manufacturer's standard.
    d. Gasket Material: Natural or synthetic rubber.
    e. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

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

    a. Description:

        1) Standard: ASSE 1079.
        2) Pressure Rating: 150 psig.
        3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

    a. Description:

        1) Standard: ASSE 1079.
        2) Factory-fabricated, bolted, companion-flange assembly.
        3) Pressure Rating: 175 psig].
        4) End Connections: Solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

    a. Description:

        1) Nonconducting materials for field assembly of companion flanges.
        2) Pressure Rating: 150 psig.
        3) Gasket: Neoprene or phenolic.
        4) Bolt Sleeves: Phenolic or polyethylene.
        5) Washers: Phenolic with steel-backing washers.

5. Dielectric Nipples:

    a. Description: Electroplated steel nipple.
    b. Standards: ASTM F492, ASME B1.20.1.
    c. Pressure Rating: 300 psig at 225 deg F.
    d. End Connections: Male threaded or grooved.
    e. Lining: Inert and noncorrosive, propylene.

2.11 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A674 or AWWA C105/A 21.5.

B. Material: High-density, cross-laminated polyethylene film of 0.004-inch or linear low-density polyethylene film of 0.008-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify excavations are to required grade, dry, and not over-excavated.

B. Verify trenches are ready to receive piping.

3.2 INSTALLATION OF ROOF DRAINS

A. Locate and install new drain body in locations shown on the Drawings. Install the new drain in a cleanly cored hole through the existing concrete precast roof double tee. Seal/plug drain to prevent water entry until service connection is completed.

B. Roof drains shall be installed in accordance with manufacturer's instructions.

C. Install manufacturer recommended collars, flanges, and deck clamps for installation in a concrete deck with spray urethane foam roofing. Set roof drains prior to spray roofing installation in order to allow the foam roofing to extend into a seal at the new roof drain,

per drawing details. The inside opening for the roof drain shall not be obstructed by the foam roofing installation.

D. Install downspout nozzles at the exposed end of the conductors as they pass through the masonry wall.

3.3 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

B. Install piping as indicated unless deviations from layout are approved on coordination drawings.

C. Install piping in concealed locations.

1. Piping installed in equipment rooms, service areas, and where indicated may be exposed.

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.

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.

1. Do not change direction of flow more than 90 degrees.
2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install piping at the following minimum slopes unless otherwise indicated.

1. Building Storm Drain: 1/4 inch per foot downward in direction of flow for piping NPS 3 and smaller; 1/4 inch per foot downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm Drainage Piping: 1/4 inch per foot downward in direction of flow.

M. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Ch IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.

N. Install steel piping in accordance with applicable plumbing code.

O. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."

P. Install aboveground ABS piping in accordance with ASTM D2661.

Q. Install aboveground PVC piping in accordance with ASTM D2665.

R. Install underground ABS and PVC piping in accordance with ASTM D2321.

S. Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

T. Install force mains at elevations indicated.

U. Plumbing Specialties:

1. Install cleanouts in storm drainage gravity-flow piping in accessible locations.

a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

V. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

W. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

X. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

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

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.4 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

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

E. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

F. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

H. Plastic, Non-pressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendices.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendices.

I. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.5 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Unshielded or shielded, non-pressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installations are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sump pump discharge.

a. Install full-port ball valve for piping NPS 2 and smaller.
b. Install gate or butterfly valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

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

3.8 CONNECTIONS

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

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
2. Install horizontal backwater valves with cleanout cover flush with floor.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections in accordance with the following unless otherwise indicated:

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

3.9 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.10 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Test Procedure:

    a. Test storm drainage piping on completion of roughing-in.
    b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
    c. From 15 minutes before inspection starts until completion of inspection, water level must not drop.
    d. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.

    a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.11 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect piping and drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Repair damage to adjacent materials caused by storm drainage piping installation.

3.12 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:

1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
6. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
7. Dissimilar Pipe-Material Couplings: Unshielded or shielded, non-pressure transition couplings.

C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:

1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: Unshielded or shielded, non-pressure transition couplings.

D. Underground storm drainage piping NPS 6 and smaller shall be any of the following:

1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, cast-iron, hubless-piping couplings; and coupled joints.
3. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded or shielded, non-pressure transition couplings.

E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:

1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, cast-iron, hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded or shielded, non-pressure transition couplings.

F. Aboveground storm drainage force mains NPS 1-1/2 and NPS 2 shall be any of the following:

1. Hard copper tube, Type L copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

G. Aboveground storm drainage force mains NPS 2-1/2 to NPS 6 shall be any of the following:

1. Hard copper tube, Type L copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
4. Fitting-type transition couplings if dissimilar pipe materials.

END OF SECTION 221414

SECTION 221429 – SUMP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Sump pumps.

1.2 DESIGN REQUIREMENTS

A. Design Criteria: Refer to schedule on project drawings.

1.3 SUBMITTALS

A. Product Data (PD)

1. Specified Products.

B. Shop Drawings (SD)

1. Installation details for pumps, piping, controls and accessories including wiring schematics.

PART 2 - PRODUCTS

2.1 SUMP PUMPS

A. Manufacturers:

1. GRUNDFOS CBS Inc.
2. Industrial Flow Solutions
3. Liberty Pumps
4. Xylem
5. Substitutions: Not permitted

B. Description: Factory-assembled and -tested sump-pump unit.

C. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.

D. Pump Casing: Cast iron, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.

E. Impeller: Statically and dynamically balanced, designed for clear wastewater handling, and keyed and secured to shaft.

F. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.

G. Seal: Mechanical.

H. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

1. Motor Housing Fluid: Oil.

I. Controls, Rod-and-Float Type:

1. Enclosure: NEMA 250
2. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
3. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
4. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 VAC, with transformer and contacts for remote alarm bell.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify connections, size, and location are as indicated on Drawings.

3.2 INSTALLATION

A. Provide necessary piping, fittings, and valves as indicated on Drawings.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation, examine, adjust and test each pump for proper operation.

B. Test each pump with clean water through minimum of four complete cycles.

3.4 MANUFACTURER'S FIELD SERVICES

A. Provide services of manufacturer's representative for period of not less than 1 day to inspect installations and for performance testing.

END OF SECTION 221429

SECTION 221500 - GENERAL SERVICE COMPRESSED-AIR SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Compressed air piping.
2. Unions and flanges.
3. Valves.
4. Strainers.
5. Pipe hangers and supports.
6. Flexible connectors.
7. Relief valves.
8. Compressed air outlets.
9. Air compressor.
10. Oil less air compressor.
11. Compressed air after cooler.
12. Refrigerated compressed air dryer.
13. Desiccant compressed air dryer.
14. Air receiver.
15. Air pressure reducing valve.
16. Pressure regulators.
17. Compressed air filters.
18. Hose connectors.
19. Underground pipe markers.

1.2 DEFINITIONS

A. SWP: Steam Working Pressure.

1.3 SUBMITTALS

A. Product Data (PD)

1. Piping: Submit data on pipe materials, fittings, and accessories.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
4. System Components: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes. When applicable, include electrical characteristics and connection requirements.
5. Compressors and Dryers: Submit type, capacity, and performance characteristics. Include electrical characteristics and connection requirements.

B. Shop Drawings (SD)

1. Indicate piping system schematic with electrical and connection requirements, general assembly of components, mounting and installation details, and general layout of control and alarm panels.

C. General (G)

1. Manufacturer's Installation Instructions: Submit hoisting and setting requirements, starting procedures.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of equipment piping, valves, outlets and components.

B. Operation and Maintenance Data: Submit assembly views, lubrication instructions, replacement part numbers and availability.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.6 WARRANTY

A. Furnish five-year manufacturer warranty for pumps, compressors, refrigerated dryers and valves excluding packing.

PART 2 - PRODUCTS

2.1 COMPRESSED AIR PIPING

A. Copper Tubing: ASTM B88 (ASTM B88M), Type K, drawn.

1. Fittings: ASME B16.18 cast copper alloy or ASME B16.22, wrought copper and bronze.
2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
3. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver solder.

B. Copper Tubing: ASTM B88 (ASTM B88M), Type K, drawn.

1. Copper Press Fittings: Conforming to ASME B16.18 cast copper alloy or ASME B16.22, wrought copper and bronze with Nitrile O-ring seals.
2. Joints: Compression type made with manufacturer’s tool.

2.2 UNIONS AND FLANGES

A. Unions for Pipe 2 inches (50 mm) and Smaller:

1. Copper Piping: Class 150, bronze unions with soldered joints.
2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches (65 mm) and Larger:

1. Copper Piping: Class 150, slip-on bronze flanges.
2. Gaskets: 1/16 inch (1.6 mm) thick preformed neoprene gaskets.

2.3 VALVES

A. Refer to Section 220523 for general valves.

2.4 STRAINERS

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 and Smaller: 0.020 inch.
    b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
    c. Strainers NPS 5 and Larger: 0.10 inch.

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

2.5 PIPE HANGERS AND SUPPORTS

A. Refer to Section 220529 for pipe hangers and supports.

2.6 FLEXIBLE CONNECTORS

A. 2 inches (50 mm) and Smaller: Corrugated bronze or stainless steel hose with single layer of bronze or stainless steel exterior braiding, copper tubing ends; maximum working pressure 170 psig, threaded or soldered connections.

B. 2-1/2 inches (65 mm) and Larger: Corrugated stainless steel hose with single layer of stainless steel exterior braiding, Class 150 flanged ends; maximum working pressure 190 psig.

2.7 RELIEF VALVES

A. Relief Valves: Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

2.8 COMPRESSED AIR OUTLETS

A. Compressed Air Outlets: Quick Connector: 1/4-inch brass, snap on connector with self-closing valve, Style V.

2.9 AIR COMPRESSOR

A. Manufacturers:

1. Atlas Copco
2. Gardner Denver
3. Ingersoll Rand
4. Quincy Compressor
5. Sauer

B. Air Compressor: Simplex, duplex, or tank mounted compressor unit consisting of air-cooled or water-cooled compressor, air receiver, after cooler, and operating controls.

C. Reciprocating Compressors:

1. Unit: Reciprocating compressor with positive displacement oil pump lubrication system, suction inlet screen, discharge service valves, on cast iron or welded steel base for motor and compressor with provision for V-belt adjustment.
2. Motor: Constant speed 1800 rpm with electronic overheating protection in each phase with full voltage starting.
3. Control Panel: Factory mounted and wired, NEMA 250 Type 3R enclosure, steel construction, with power and control wiring, molded case disconnect switch, factory wired for single point power connection.

    a. Starter: Furnish with manual reset current overload protection, starter relay, control power transformer, terminal strip for connection to interface equipment.
    b. Safety Controls: Manually reset low oil pressure cutout.
    c. Panel Face: Compressor run light, start-stop switch, elapsed time meter.

D. Screw Compressors:

1. Unit: Direct drive, open drive, 3600 RPM, fixed compression, rotary screw compressor with control panel.
2. Features: Differential pressure oil pump, oil separator and filter, oil charging valve, compressor bearings with ABMA 9 L10 life expectancy at 100,000 hours.
3. Motor: Open drip proof flange squirrel cage induction, close coupled to compressor.
4. Control Panel: Factory mounted and wired NEMA 250 Type 3R enclosure, with starter and refrigeration controls including:

    a. Non-fused molded case, disconnect switch.

b. Single point power connection and grounding lug.
c. Anti-recycle timer.
d. Solid state overload relay for each compressor.
e. Phase loss-reversal monitor.
f. Cycle counter and hour meter for each compressor.
g. Automatic shutdown on compressor overload.

5. Automatic Capacity Reduction: Continuously variable slide valve with infinitely variable control to 25 percent of full load.

E. Thermostatic Water Valve: To maintain water temperature through compressor at 98 degrees F (37 degrees C) to 109 degrees F (43 degrees C).

F. Controls:

1. Pressure Switch: Line voltage contactor to break at 100 psi (690 kPa) with minimum differential of 20 psi (138 kPa).
2. Compressor Regulation: Lead-lag switch with time delay relay.
3. Electrical Alternation: Operate lead compressor for 12-hour time period. When lead compressor fails, start second compressor to automatically maintain air pressure.

G. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box.

H. Disconnect Switch: Factory mount in control panel or on equipment.

2.10 COMPRESSED AIR AFTERCOOLER – WATER-COOLED

A. Manufacturers:

1. Aircel
2. IPAC, Inc.
3. Kaeser Compressors, Inc.

B. Construction: Removable tube nests of non-ferrous metal tubes and corrosion resistant tube plates, safety valves, pressure gage, moisture separator, moisture drain valve, water inlet piping with automatic water valve, automatic condensate trap and overflow piping with open funnel.

C. Working Pressure: 135 psi (930 kPa).

D. Discharge: Cool air to within 12 degrees F (-11 degrees C) of ambient air temperature at specified flow capacity.

2.11 REFRIGERATED COMPRESSED AIR DRYER

A. Manufacturers:

1. Atlas Copco
2. Ingersoll Rand

3. Kaeser Compressors, Inc.
4. Zeks Compressed Air Solutions

B. Refrigerated Air Dryer: Self-contained mechanical refrigeration type complete with heat exchanger, refrigeration compressor, automatic controls, moisture removal trap, internal wiring and piping, and full refrigerant charge.

C. Air Connections: Inlet and outlet connections at same level, factory insulated.

D. Heat Exchangers: Air to air and refrigerant to air coils. Furnish heat exchangers with automatic control system to bypass refrigeration system on low or no-load condition.

E. Moisture Separator: Centrifugal type located at discharge of heat exchanger.

F. Refrigeration Unit: Hermetically sealed type to operate continuously to maintain specified 21 degrees F (-6 degrees C) dew point. House unit in steel cabinet with access door and panel for maintenance and inspection.

G. Accessories: Air inlet temperature gage, air inlet pressure gage, on/off switch, high temperature light, power on light, refrigerant gage, air outlet temperature gage, and air outlet pressure gage.

H. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box.

I. Disconnect Switch: Factory mount in control panel or on equipment.

2.12 DESICCANT COMPRESSED AIR DRYER

A. Manufacturers:

1. Ingersoll Rand
2. Kaeser Compressors, Inc.
3. Van Air Systems, Inc.
4. Zeks Compressed Air Solutions

B. Desiccant Compressed Air Dryer: Self-contained, single or dual tower type containing absorbent desiccant, complete with drain connection, and controls.

C. Operation: Solid state controller automatically switches operation between towers; NEMA 250 Type 1 enclosure.

D. Towers: ASME Section VIII designed and constructed pressure vessels. Design Working Pressure: 150 psig. Flange or threaded inlets and outlets.

E. Components:

1. Automatic float drain valve.
2. Single or dual coalescing-particulate pre-filter.
3. Single or dual particulate after-filter.
4. Air inlet temperature gage mounted on each tower.
5. Air inlet pressure gage mounted on each tower.

6. On-off switch.
7. Pressure gage mounted on each tower.
8. Pressure relief valve mounted on each tower.
9. Adjustable air purge control.
10. Purge air flow indicator.
11. Purge muffler.

F. Accessories:

1. -100-degree F (-73 degree C) dew point control.
2. Three valve bypass.
3. Odor removal filter.
4. Switching failure alarm.

2.13 AIR RECEIVER

A. Air Receiver: Vertical or horizontal, built to ASME Section VIII regulations for working pressure of 125 psi (860 kPa). Flange or screw inlet and outlet connections.

B. Fittings: Adjustable pressure regulator, safety valve, pressure gage, drain valve, and automatic float actuated condensate trap.

C. Tank Finish: Shop primed and painted.

2.14 AIR PRESSURE REDUCING VALVE

A. Air Pressure Reducing Valve: Consisting of automatic reducing valve and bypass, and low-pressure side relief valve and gage. Furnish oil separator.

B. Valve Capacity: Reduce pressure from 200 psi (1380 kPa) to 30 psi (207 kPa), adjustable upward from reduced pressure.

2.15 PRESSURE REGULATORS

A. Pressure Regulators: Diaphragm or pilot operated, bronze body, direct acting, spring loaded, manual pressure setting adjustment, rated for 250 psig (1725 kPa) inlet pressure.

2.16 COMPRESSED AIR FILTERS

A. Mechanical Separation Filter: 2 stage. Furnish with deflector plates, resin impregnated ribbon type filters with 40 micron (0.040 mm) thick edge filtration and drain valve.

B. Coalescing Filters: Furnish with activated carbon capable of removing water and oil aerosols, with color-change dye indicating when carbon is saturated and warning light indicating when maximum pressure drop has been exceeded.

2.17 HOSE CONNECTORS

A. Hose Connectors: Corrugated stainless steel tubing with stainless steel wire braid covering and ends welded to inner tubing.

B. Working Pressure: 250 psig (1725 kPa) minimum.

C. End Connections:

1. 2 inches (50 mm) and Smaller: Threaded steel pipe nipple.
2. 2-1/2 inches (65 mm) and Larger: Class 150 Flanges.

2.18 UNDERGROUND PIPE MARKERS

A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

B. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Compressed Air Service" in large letters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify excavations are to required grade, dry, and not over-excavated.

B. Verify connection size, location, and invert are as indicated on Drawings.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - INSERTS

A. Provide inserts for placement in concrete forms.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches (100 mm) and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above, flush with top of, or recessed into and grouted flush with slab as required.

3.4 INSTALLATION - HANGERS AND SUPPORTS

A. Install hangers and supports in accordance with ASME B31.9 and MSS SP 58.

3.5 INSTALLATION - BURIED PIPING SYSTEMS

A. Establish elevations of buried piping with not less than 12 inches of cover.

B. Establish minimum separation of 5 feet from other services.

C. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.

D. Install pipe on prepared bedding.

E. Route pipe in straight line.

F. Install pipe to allow for expansion and contraction without stressing pipe or joints.

G. Install trace wire continuous over top of piping system.

H. Coordinate provision of utility warning and identification tape with backfill operation. Install above buried piping at depth of 8 to 12 inches (200 to 300 mm) below finish grade.

I. Pipe Cover and Backfilling:

1. Maintain optimum moisture content of fill material to attain required compaction density.
2. After pressure testing, evenly backfill entire trench width by hand placing backfill material and hand tamping in 4 inches compacted layers to 6 inches minimum cover over top of pipe. Compact to 95 percent maximum density.
3. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
4. Do not use wheeled or tracked vehicles for tamping.

3.6 INSTALLATION - ABOVE GROUND PIPING - COMPRESSED AIR SYSTEMS

A. Install drip connections with valves at low points of piping system.

B. Install take-off to outlets from top of main, with shut off valve after take-off. Slope take-off piping to outlets.

C. Install compressed air couplings, female quick connectors, and pressure gages as indicated on Drawings.

D. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.

E. Cut pipe and tubing accurately and install without springing or forcing.

F. Slope piping in direction of flow.

G. Stainless Steel Pipe with press-type Joints: Square cut ends to plus or minus 0.030 inches (0.76 mm) tolerance. Remove burrs and clean ends. Fully insert tubing into fitting and mark pipe ends to ensure full insertion into coupling or fitting during assembly. Press joint using manufacturer's tool with proper sized jaw.

H. Copper Pipe with press-type Joints: Remove burrs and clean ends. Fully insert tubing into fitting and mark pipe ends to ensure full insertion into coupling or fitting. Check alignment against mark to assure tubing is fully inserted. Press joint using manufacturer's tool.

I. Install pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions. Refer to Section 22 05 00.

J. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.

K. Install pipe identification in accordance with Section 22 05 53.

L. Except where indicated, install manual shut off valves with stem vertical and accessible for operation and maintenance.

M. Install strainers on inlet side of pressure reducing valves

N. Install strainers on inlet side of pressure regulators.

3.7 INSTALLATION - EQUIPMENT

A. Install air compressor on concrete housekeeping pad, minimum 3-1/2 inches (87 mm) high and 6 inches (150 mm) larger than compressor base on each side.

B. Install air compressor unit on vibration isolators. Level and bolt in place.

C. Install air valve and drain connection on horizontal casing.

D. Install line size shut-off valve and check valve on compressor discharge.

E. Install replaceable cartridge type filter silencer for each compressor.

F. Install shut-off valve on water inlet to after cooler. Pipe drain to floor drain.

G. Install condensate drain piping to nearest floor drain.

H. Install bypass with valves around air dryer. Use factory insulated inlet and outlet connections.

I. Provide bypass with valves, around receivers.

3.8 FIELD QUALITY CONTROL

A. Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.9.

B. Verify for atmospheric pressure in piping systems, other than system under test.

C. Test system with dry compressed air or dry nitrogen with test pressure in piping system at 50 psi (345 kPa).

3.9 CLEANING

A. Blow systems clear of free moisture and foreign matter.

3.10 SCHEDULES

PIPE HANGER SPACING		
PIPE SIZE Inches (mm)	MAXIMUM HANGER SPACING Feet (m)	HANGER ROD DIAMETER Inches (mm)
1/2 (12)	7 (2.1)	3/8 (9)
3/4 (20)	7 (2.1)	3/8 (9)
1 (25)	7 (2.1)	3/8 (9)
1-1/4 (32)	7 (2.1)	3/8 (9)
1-1/2 (38)	9 (2.7)	3/8 (9)
2 (50)	10 (3)	3/8 (9)
2-1/2 (65)	11 (3.4)	1/2 (13)
3 (75)	12 (3.7)	1/2 (13)
4 (100)	14 (4.3)	5/8 (15)
5 (125)	16 (4.9)	5/8 (15)
6 (150)	17 (5.2)	3/4 (19)
8 (200)	19 (5.8)	3/4 (19)
10 (250)	22 (6.1)	7/8 (22)
12 (300)	23 (7)	7/8 (22)
14 (350)	25 (7.6)	1 (25)
16 (400)	27 (8.2)	1 (25)
18 (450)	28 (8.5)	1 (25)
20 (500)	30 (9.1)	1-1/4 (32)
24 (600)	32 (9.8)	1-1/4 (32)
PVC (All Sizes)	6 (1.8)	3/8 (9)

END OF SECTION 221500

SECTION 221521 – SKID MOUNTED AIR COMPRESSOR SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. SECTION INCLUDES

1. Air Compressor System Skid
2. Air Receiver
3. Air Compressors
4. Compressor Electric Motors
5. Compressor Control Panel
6. Pressure Transmitters
7. Stainless Steel Tubing and Fittings
8. Steel Pipe and Fittings
9. Hose and Couplings
10. Pressure Gages
11. Safety Relief Valves

1.2 SUBMITTALS

A. Shop Drawings (SD):

1. Compressor Assembly / Skid base drawing (pdf) and AutoCAD DWG file(s) or parametric solid model (SolidWorks assembly model preferred).
2. P&ID schematic diagram(s) of air compressor system, provide both pdf file(s) and AutoCAD DWG file(s).
3. Electrical schematic and wiring diagrams of air compressor control panel, provide both pdf file(s) and AutoCAD DWG file(s).
4. Manufacturer to provide complete bill of materials for the air compressor, and the air compressor control panel for all major components for future maintenance use by CAWCD.

B. Product Data (PD):

1. Operation and Maintenance Manual(s)
2. Manufacturer’s catalog data or product cut sheets for all OEM components included on bill of materials.
3. Manufacturer’s installation instructions.
4. Manufacturer to provide list of recommended spare parts with O&M Manual.
5. Pressure Vessels:

a. Provide a copy of the "Manufacturer's Data Report for Pressure Vessels" and certificates for each pressure vessel as recorded by the National Board.
b. Certification of welders and qualified welding procedure per ASME Section IX. Provide Welding Inspection Reports, as applicable.

C. Quality Control Reports (QCR):

1. Safety Relief Valve(s):

    a. Shall be tagged with NB certification stamp according to ASME code requirements.

2. Factory Acceptance Test Report.
3. Calibration tags:

    a. Attach a calibration and testing tag to any applicable instrumentation, piece of equipment, or system.
    b. Sign the tag when calibration is complete.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum 5 years' experience.

B. Code(s), Material, and Installation:

1. The design code(s), pressure(s), and temperature(s) for this installation are as follows:

    a. Piping Code: ASME B31.3, Process Piping
    b. ASME Code(s): Section VIII Division 1, “Rules for Construction of Pressure Vessels”; Section II, “Materials”; Section V, “Nondestructive Examination”; and Section IX, “Welding and Brazing Qualifications”.
    c. See project documents for system MAWP.

2. Control Panel(s) if applicable:

    a. Fabricate per and comply with UL 508A, Standard for Industrial Control Panels.
    b. Enclosure(s) to be NEMA 4 Minimum.
    c. Comply with National Electric Code.

3. Power Distribution Panelboard(s) (if applicable):

    a. Fabricate per and comply with UL 67, Standard for Panelboards.
    b. Enclosure(s) to be NEMA 4 Minimum.
    c. Comply with National Electric Code.

4. Pressure Vessels:

    a. Pressure vessels shall be registered with the National Board and must have a U stamp.

C. Factory Acceptance Testing:

1. General

a. The Manufacturer shall furnish all necessary labor, material, and equipment, including test fittings, piping, calibrated test instruments, and all other necessary equipment to perform the testing and reports required herein.
b. Manufacturer shall furnish complete shop drawings, panel inspection forms, and final PLC program to CAWCD 30 days prior to FAT.
c. Manufacturer shall provide a minimum 30-day notice of FAT availability to CAWCD.
d. Before shipment to the CAWCD site, the complete control system including all PLCs, and peripherals shall be assembled, connected, and all software loaded for a fully functional FAT of the integrated system.
e. Right of observation: The CAWCD retains the right to observe all factory test activities including all subsystem preparation, pretests, troubleshooting, retests, warm-up, and software modification and/or update.
f. CAWCD reserves the right to test any specified function, whether explicitly stated in the test submittal.
g. Any deficiencies in design, materials, or workmanship shall be corrected to meet the specified requirements and the tests repeated until successfully completed.

2. Preliminary FAT

a. A preliminary factory acceptance test (pre-FAT) shall be conducted utilizing the test plans, procedures and forms approved by the CAWCD.
b. Submit the pre-FAT test results: include a letter, signed by the Contractor's project manager or company officer, certifying that the system is complete, has been tested successfully, and is fully ready for the full, witnessed FAT.
c. The submittal shall include completed pre-FAT test forms, signed by the Manufacturer's staff, and shall be submitted for review 14 - days before the start of the FAT.

3. Performance Testing

a. Verify required flowrate (SCFM) at rated pressure.
b. All fittings and joints shall be checked for leakage at MAWP.
c. Manufacturer shall verify correct settings on all pressure relief devices on the compressor skid.
d. Manufacturer shall verify correct operation of system protective relays and requested system outputs.
e. Manufacturer shall demonstrate compressor system automatic and manual operation and alarm responses.
f. Manufacturer shall demonstrate operation of each individual PLC I/O point. I/O test form to include rack/slot/number of I/O point, program tag name and description, alarm set points, panel terminal block numbers, witness signature lines, and check-off for correct responses for each point.

PART 2 - PRODUCTS

2.1 AIR COMPRESSOR SYSTEM SKID

A. All equipment provided under this purchase contract shall be supplied pre-assembled, and factory tested, as a skid mounted system.

1. Include appropriate lugs for lifting and / or positioning skid as required.
2. Skid should be constructed in a way that allows the safe use of a forklift or pallet truck to move the unit during shipment and installation.
3. Separate skids shall be provided for each air compressor due to clearance constraints in existing plant.
4. Component layout and instrumentation shall be designed to facilitate maintenance.
5. Provide consideration for access to filters, oil changes, oil sampling, safety relief valves and isolation valves.
6. Include appropriate instrumentation to facilitate system maintenance, inspection and troubleshooting.

    a. Compressor stage pressure gauges.
    b. Compressor exhaust temperature switch w/ dial, compressor run hour meter, and oil level sight gauge.

7. A shrouded compressor unit is not required. The compressor will be installed in a controlled facility where only authorized personnel will have access to the unit for maintenance and operation.
8. Cooling air requirements:

    a. The compressor cooling fan should be positioned with adequate clearance to provide for proper air flow per the manufacturer's requirements within the skid envelope.
    b. Provide CAWCD with clearance requirements around skid to ensure adequate cooling air flow.

B. Ensure compressor system design and installation conform to CAGI B19.1 (Safety Standard for Compressor Systems).

1. Include appropriate guarding for fans, drive components, and other moving parts to ensure personnel safety as required.

C. Skid mounted system requirements:

1. Everything required to operate the compressor shall be supplied with the compressor skid, with the exception of the remote pressure transmitter or switch provided to monitor system pressure and determine compressor on/off status which shall be supplied loose with the compressor for field installation.
2. Skid Mounted System Overall Dimensions:

    a. See project documents for overall dimensions.

2.2 AIR RECEIVERS

A. Air Receiver: Vertical, built to ASME Section VIII regulations for working pressure as shown on project documents. Flange or screw inlet and outlet connections.

B. Fittings: Safety valve, pressure gage, drain valve, inspection port and automatic condensate drain with zero air loss (BEKOMAT or CAWCD approved equivalent).

C. Air receiver tank shall include appropriate lifting lugs for lifting and/or positioning equipment as required.

D. Tank Finish: Abrasive blasted and factory exterior and interior epoxy prime coated.

E. Hydrostatic Test Pressure: 1.5 x MAWP.

2.3 AIR COMPRESSORS

A. Compressors shall be multistage, Air Cooled, 24/7 continuous duty cycle rated.

B. Each rated at a minimum airflow and pressure as shown on the drawings.

1. Compressor shall be rated no more than 25% above the minimum pressure rating.
2. Maximum compressor airflow (in SCFM) at required pressure with a motor less than or equal to horsepower shown on the drawings will be given preference when evaluating proposals.

C. Air cooled inter-stage coolers shall be provided after every stage of compression. After final stage of compression air cooled aftercooler shall be capable of cooling the discharge air to within 20°F of ambient air temperature.

D. Air compressor(s) shall be equipped with an automatic condensate drain system.

1. Automatic condensate drain system shall exhaust to separate mechanical demisters prior to discharging to system drain.
2. Solenoid operated drain valves should be powered and controlled from the skid's control panel unless approved otherwise by CAWCD.

E. The air compressor(s) final stage shall be equipped with appropriately rated, field replaceable, safety relief valve on the compressor discharge.

F. The air compressor(s) shall be provided with a factory installed, field replaceable, check valve on the compressor discharge.

G. Air compressor control system shall be programmed to alternate compressor A and B as the lead every 10 starts.

2.4 COMPRESSOR ELECTRIC MOTORS

A. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.

1. Voltage: 460 volts, three phase, 60 Hz.
2. Service Factor: 1.25.
3. Enclosure: Meet conditions of installation unless specific enclosure is NEMA IP 55.
4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
5. Insulation System: NEMA Class F.
6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for re-lubrication, rated for minimum ABMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
9. Sound Power Levels: Conform to NEMA MG 1.

B. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.5 Compressor control panel

A. Enclosure: Shall be NEMA 4, steel enclosure, suitable for wall mounting, with a locking hinged door. Enclosure shall be painted ANSI 61 Grey enamel over phosphatized and primed surfaces.

B. Overcurrent protection:

1. Main overcurrent device:

a. Where the electrical power supply voltage to the control panel is more than 120 VAC, provide the panel with a flange mounted disconnect handle operating a non-fused disconnect switch, and provide a control power transformer for 120 VAC circuits:

1) Door-mounted disconnect handles are not acceptable.
2) Mechanically interlock the disconnect switch with the control enclosure doors so that no door can be opened unless the power is disconnected, and the disconnect switch cannot be closed until all doors are closed.
3) Provide means to defeat the interlock.
4) Lockable in the off position.

b. Control panels supplied with 480 VAC:

1) Provide an internal breaker with the line side terminals covered by a barrier.
2) Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring the source to be disconnected before opening the door to the enclosure.

2. Selection and ratings of protective devices:

    a. Interrupting ratings: Not less than the system maximum available fault current at the point of application.
    b. Voltage rating: Not less than the voltage of the application.
    c. Select current rating and trip characteristics to be suitable for:

        1) Maximum normal operating current.
        2) Inrush characteristics.
        3) Coordination of the protective devices to each other and to the source breaker feeding the panel.

3. Control circuit fuses:

    a. Provide durable, readily visible label, clearly indicating the correct type, size, and ratings of replacement for each fuse.
    b. Manufacturer: One of the following or equal:

        1) Ferraz Shawmut.
        2) Littelfuse.
        3) Bussmann.

4. Control circuit fuse holders:

    a. Modular type:

        1) DIN rail mounting on 35 millimeters rail.
        2) Touch safe design: All connection terminals to be protected against accidental touch.
        3) Incorporates blown fuse indicator.

    b. Manufacturer: One of the following or equal:

        1) Phoenix Contact.
        2) Allen-Bradley.

5. Control circuit breakers:

    a. DIN rail mounting on 35 millimeters rail.
    b. Manual OPEN-CLOSE toggle switch.
    c. Rated as required for the application.
    d. Interrupting rating: 10 kiloampere (kA) or available fault current at the line terminal, whichever is higher.
    e. Current ratings: As indicated on the Drawings or as required for the application.
    f. Manufacturer: One of the following or equal:

        1) Allen-Bradley
        2) Eaton.
        3) Square D.

C. Conductors and cables:

1. Power and control wiring within the enclosure:

    a. Materials: Stranded, soft annealed copper.
    b. Insulation: 600 volts type MTW.
    c. Minimum sizes:

        1) Primary power distribution: 12 AWG.
        2) Secondary power distribution: 14 AWG.
        3) Control: 16 AWG.

    d. Color Coding for Phase Identification, 600 V or Less:

        1) Color shall be factory applied.

            a) Colors for 120/208 V Circuits:
                (1) Phase A: Black.
                (2) Phase B: Red.
                (3) Phase C: Blue.
                (4) Colors for 277/480V Circuits:
                (5) Phase A: Brown.
                (6) Phase B: Orange.
                (7) Phase C: Yellow.
                (8) AC control: RED.
                (9) DC power and control (ungrounded): BLUE.
                (10) DC power and control (grounded): WHITE with BLUE stripe.
                (11) Ground: GREEN.

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

    a. Encore Wire.
    b. General Cable.
    c. Southwire.

D. Conductor identification:

1. Identify conductors and cables with unique wire numbers.
2. Readily identified without twisting the conductor.
3. Heat-shrink preprinted wire labels:

    a. Flame-retardant polyolefin tube with machine-printed identification label.
    b. Sized to suit diameter of and shrinks to fit firmly around cable it identifies.
    c. Full shrink recovery at a maximum of 200 deg F. Comply with UL 224.
    d. Legend to match cable name(s) presented on construction drawings.

E. General wiring requirements:

1. Wiring methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.

2. Install all components in accordance with the manufacturer's instructions included in the listing and labeling.
3. Provide nonmetallic ducts for routing and organization of conductors and cables. Size ducts for ultimate build-out of the panel, or for 20 percent spare, whichever is greater.
4. Cables within the panel not in nonmetallic ducts shall be fastened with cable mounting clamps or with cable ties in a neat and secure manner. Cable mounting clamps shall be attached to the back panel with small machine screws.
5. The free ends of cable ties shall be cut flush after final adjustment and fastening.
6. Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.
7. Support panel conductors where necessary to keep them in place.
8. Conductors and cables shall be run from terminal to terminal without splice or joints.

F. Compressor Control Panel shall include:

1. Automatic direct motor starter with three-phase contactor, thermal overload relay, and adjustable overload protection.
2. Control voltage power transformer. Shall be powered from taps off main 480V primary feed to compressor skid. Secondary shall be 120V with fuse protection. Breakers shall be provided to isolate the transformer from the compressor main 480V power feed.
3. 24VDC Power Supply. Power supplies shall be equipped with line and individual load circuit protection and sized to 150% of the calculated design load. Power supplies shall be powered from the control voltage power transformer and sourced from the following manufacturers and series.

    a. Phoenix Contact QUINT
    b. Murr Elektronik Emparro
    c. Allen Bradley 1606-XLS series
    d. Equivalent rugged or performance series power supply approved by CAWCD.

4. All door mounted devices shall be rated NEMA 4.

G. Air compressors system shall be PLC controlled. Compressor system shall be factory wired and equipped with manufacturer recommended protective circuitry and appropriate outputs, at a minimum each compressor shall be equipped with:

1. Programmable Logic Controller.

    a. Rockwell Compactlogix 5380 hardware platform utilizing Studio 5000 programming software.
    b. Flashed to firmware revision 31 prior to initial programming.
    c. Equipped with screw-type power and I/O terminals.
    d. 24VDC input power.
    e. Approved I/O modules:

        1) Digital input: 5069-IB16
        2) Digital output: 5069-OB16
        3) Analog input: 5069-IF8

4) Selection of additional modules outside of the above list requires CAWCD approval.

2. HMI Touchscreen

   a. Rockwell Panelview Plus 7 series.
   b. 10'' minimum screen size.
   c. 24VDC Powered with ethernet connection to system PLC.

3. Pilot Devices.

   a. Provide operator pushbuttons, switches, and pilot lights, from a single manufacturer.
   b. Furnish 1 spare normally open contact and normally closed contact with each switch or pushbutton.
   c. Size – 30 millimeters, NEMA 4/4X, heavy duty type.
   d. Push buttons – Contacts rated NEMA Type A600.
   e. Pilot lights – LED type, push to test.
   f. Pilot lights – Lamp color:

      1) On/Running/Start/Open: Red
      2) Off/Stop/Closed: Green
      3) Power: White.
      4) Status or normal condition: White
      5) Alarm/Failure: Amber

   g. Manufacturers:

      1) Allen-Bradley Type 800T
      2) IDEC TWTD

4. Low Oil level switch / alarm.

   a. Fault to be indicated with amber fault lights or on skid HMI touchscreen.

5. High Air Compressor Exhaust Temperature switch / alarm.

   a. Fault to be indicated with amber fault lights or on skid HMI touchscreen.

6. Compressor fault indication control relays / alarms.

   a. Fault to be indicated through amber fault light and relay alarm output.
   b. Compressor A and B Failure Alarm Outputs: Use specified control relay, connect to compressor failure alarm output from compressor PLC. Provide output from Normally Open contact from control relay to be wired to terminals for CAWCD use in the plant control system (CAWCD's control system is 125VDC, relay contacts must be rated appropriately).

7. Compressor control power indication and failure alarm.

   a. Control Power On/Off indication light.
   b. Compressor Control Power Failure Alarm Output: Use 120VAC control relay, connect to power feed from secondary of control voltage power transformer.

Provide output from Normally Closed contact from control relay to be wired to terminals for CAWCD use in the plant control system (CAWCD's control system is 125VDC, relay contacts must be rated appropriately).

8. Terminal Blocks

    a. Din rail mounting on 35 mm rail.
    b. Suitable for specified AWG wire.
    c. Rated for 30 amperes at 600 volts.
    d. Screw terminal type.
    e. Finger safe protection for all terminals for conductors.
    f. Construction: Polyamide insulation material capable of withstanding temperature extremes from - 40 degree Celsius to 105 degrees Celsius.
    g. Terminals: Plainly identified to correspond with markings on the diagrams. Permanent machine printed terminal identification
    h. Position:

        1) So that the internal and external wiring does not cross.
        2) To provide unobstructed access to the terminals and their conductors.

    i. Provide minimum 25 percent spare terminals.
    j. Heavy duty terminal blocks as required by the application are to be securely mounted to housing enclosures, suitable for #10 AWG wire and accept ring lug terminals. Jumper bar assemblies shall be installed for interconnecting terminal blocks and distributing power and signal commons as required. Terminal blocks shall be rated for 600 V, 75 A, and have a minimum of 12 points with hinge cover.
    k. Manufacturers:

        1) Phoenix Contact
        2) Allen-Bradley
        3) Marathon 1500 Series (Heavy Duty)

    l. Each rung on all terminal blocks shall be numerically labeled. The first rung shall be 1, and the number shall increase sequentially, by one, for each rung on the device.

9. Alarm Terminal and Terminal Block ratings (for CAWCD requested compressor status alarms):

    a. Terminals shall be rated Q600 per NEMA ICS 5-2000 (Continuous = 2.5 Amps, Make or Break = 0.55 Amps at 125 VDC).

10. Special-purpose Oil System Interlock Relay: The DVOS compressor system interfaces with the DVOS oil pump through a string of interlocking normally closed contacts located within a remote panel. New DVOS compressor system to include a special-purpose interlock relay for connection the oil pump interlock contacts.

    a. Oil system interlock relay hardware specification to adhere to alarm relay hardware in section 11.

b. Oil system interlock relay coil positive to be supplied with a dedicated field terminal for outside connection and delivered with a factory jumper to the compressor system 24VDC.
c. Relay to have one normally open contact wired to a digital input on the compressor system PLC for monitoring of the oil system interlock.
d. Relay to have one normally open contact wired in series with the compressor 1 and 2 motor starters, preventing the motor contactors from energizing if the oil system interlock relay is not energized.

11. Control Relays (Plant Alarm Relays) configured from the following manufacturers.

    a. Relay Module (24VDC Coil): Potter & Brumfield KUEP11D1524
    b. Relay Module (120VAC Coil): Potter & Brumfield KUEP11A15120
    c. Socket: Finder 9203SMA
    d. All relay sockets must include Finder 9902002498 Varistor/LED Module
    e. Provide a minimum of 1 alarm relay per panel for future alarm outputs.

12. Control Relays (Non-Alarm) from the following manufacturers.

    a. Phoenix Contact
    b. Allen Bradley
    c. IDEC
    d. Or approved Equal

13. Timer Modules:

    a. Furnish timer modules to provide accurate overall eclipsed run time of each compressor.

        1) NEMA Type 4X or 4
        2) 24VDC Input Power.
        3) LED display.
        4) Minimum 10,000-hour maximum time range.
        5) Manufacturers: Dwyer, Autonic, or approved alternate.

14. All devices on the compressor skid requiring control power shall be routed to this cabinet, unless approved otherwise.

2.6 PRESSURE TRANSMITTERS

A. Manufacturer to provide Lead / Lag pressure transmitter to control the compressor operation.

1. Manufacturer to provide terminals inside Compressor Control Panel to interface with pressure transmitter to control operation of the individual air compressor.
2. Transmitters shall be provided with at least 20’ of cable to connect to CAWCD VOS Air Receiver System.
3. Transmitter shall be 24VDC or loop powered, with an analog 4-20mA signal to the system PLC.

B. Lead Pressure Transmitter Programming

1. Compressor 1 (lead) pickup at 575 psig, drops out at 600 psig.

C. Lag Pressure Transmitter Programming

1. Compressor 2 (lag) pickup at 550 psig, drops out at 600 psig.

D. Pressure Transmitter Manufacturers:

1. Schneider Electric (Square-D), Series 9012G, NEMA Electromechanical Pressure Transmitters, Control Circuit Rated.
2. IFM, Efectrosoo, PK6220, Pressure Switch.
3. Or approved equal.

2.7 STAINLESS STEEL TUBING AND FITTINGS (up to 2 inches)

A. Tubing: Stainless Steel Tubing: ASTM A269, seamless, annealed, Type 304 or 316.

B. Fittings: Stainless Steel (316), ASTM A276 bar stock, or ASTM A182 forgings

2.8 STEEL PIPE AND FITTINGS (Up to 2 inches)

A. Pipe: Black steel, ASTM A53

B. Fittings: Steel, ASTM A234, Grade WPB

C. Joints: Threaded Fittings.

2.9 HOSE AND COUPLINGS

A. Hose supplied with skid mounted air compressor systems that are designed to operate under a sustained pressure greater than 150 psig shall:

1. Undergo a minimum 5-minute hydrostatic test at 1.5 x DP certified by the original hose manufacturer or third-party certified testing agency after crimp connections have been installed on the hose.
2. Design Pressure for air lines shall be MAWP.
3. Shall also be installed with hose whip restraints at both ends of the hose.

B. Air Hose

1. Hose, Minimum Requirements: Nylon Thermoplastic with Sythentic Fiber Reinforcement, SAE 100R7 or 100R8 depending on application.
2. Hose Ends: NPT or 37° JIC Fittings, Swivel Couplings, Elbows shall be Long Drop if required.
3. Manufacturer / Product Information:

a. Parker Hannifin Corporation, Hose Products Division
b. Flextral
c. Or approved equal.

C. Hose Whip Restraints

1. Manufacturer / Product Information:

a. Parker Hannifin Corporation, Hose Products Division
b. Or approved equal.

2.10 PRESSURE GAGES

A. ASME B40.100, Grade 1A, Scale twice the system working pressure, non shatterable safety glass.

2.11 SAFETY RELIEF VALVES

A. Provide ASME BPVC Sec VIII D1 and ASME BPVC Sec IX code stamped pressure relief valve and piping to allow safe discharge in the event of a release.

PART 3 - EXECUTION

3.1 START-UP / COMMISSIONING SUPPORT

A. Manufacturer to provide installation inspection and certification services on behalf of CAWCD.

B. Include one day of on-site start-up support by manufacturer's service technician.

1. Start-up support to include basic operation and troubleshooting orientation.
2. CAWCD to provide minimum 2 week notice of start-up date.

C. Performance Test

1. Provide a competently trained technician or programmer on call for the Project Site during all normal working days and hours from the start of the performance test until final acceptance of the system.

a. Response time to the project site shall be 24 hours less for a major failure

2. Performance test duration: 14 days

D. Failures

1. Minor failure:

a. A small and non-critical component failure or software problem that can be corrected by the CAWCD’s operators.
b. Log this occurrence but this is not a reason for stopping the test and is not grounds for non-acceptance.
c. Should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance.

2. Major failure:

    a. Considered to have occurred with a component, subsystem, software control, or program fault causes a halt in or improper operation of the system and/or when a technician's work is required to make a repair or re-initiate operation of the system.
    b. Causes termination of the performance test.
    c. Start a new acceptance test when the causes of a major failure have been corrected.
    d. A failure is also considered major when failure of any control system that results in an overpressure, under-pressure, failed start, or failed switch occurs.

END OF SECTION 221521

SECTION 223300 - ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial electric water heaters.

1.2 SUBMITTALS

A. Shop Drawings: Indicate water heater dimensions, size of taps, expansion tank piping/ mounting, pump piping/ mounting, T&P piping, and clearances to structural components within room. Indicate dimensions of manufacturer recommended clearances, tank dimensions, anchors, attachments, lifting points, taps, and drains.

B. Product Data: Dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Submit electrical characteristics and connection locations.

1. Manufacturer's Installation Instructions: Mounting and support requirements.
2. Manufacturer's Certificate: Products meet or exceed specified requirements.

1.3 QUALITY ASSURANCE

A. Water Heater Performance Requirements: Equipment efficiency not less than prescribed by ASHRAE 90.1.

B. Manufacturer: Company specializing in manufacturing products specified in this Section with three years' experience, and with service facilities within 100 miles (161 km) of Project.

C. Installer: Company specializing in performing Work of this Section with five years' experience.

1.4 WARRANTY

A. Furnish five-year manufacturer warranty for domestic water heaters.

PART 2 - PRODUCTS

2.1 COMMERCIAL ELECTRIC WATER HEATERS

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

1. Bock.
2. Bradford White Corporation.
3. Lochinvar Corporation.
4. PVI Industries, LLC.
5. Rheem Manufacturing Company.
6. Substitutions: Not permitted.

B. Type: Factory-assembled and wired, electric, vertical storage.

C. Maximum working pressure: 150 psig.

D. Tank: Glass-lined welded steel; 4-inch (100 mm) diameter inspection port, thermally insulated with minimum 2 inches (50 mm) glass fiber or polyurethane encased in corrosion-resistant steel jacket; baked-on enamel finish.

E. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 160 degrees F, flanged or screw-in nichrome elements, high temperature limit thermostat.

F. Accessories: Brass water connections and dip tube, drain valve, magnesium anode, and ASME rated temperature and pressure relief valve.

G. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 Watts per square inch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Maintain manufacturer's recommended clearances around and over water heaters.

B. Install water heater on concrete housekeeping pad, minimum 3-1/2 inches (87 mm) high and 6 inches (150 mm) larger than water heater base on each side.

C. Connect domestic hot water and domestic cold-water piping to outlet and inlet water heater connections.

D. Install following piping accessories.

1. Supply:

a. Strainer.
b. Shutoff valve.

2. Return:

    a. Thermometer well and thermometer.
    b. Shutoff valve.

E. Install discharge piping from relief valves and drain valves per plumbing drawings.

F. Install water heater trim and accessories furnished loose for field mounting.

G. Install electrical devices furnished loose for field mounting.

END OF SECTION 223300

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flush valve water closets.
2. Tank type water closets.
3. Wall hung urinals.
4. Lavatories.
5. Sinks.
6. Showers.
7. Drinking fountains.
8. Electric water coolers.
9. Service sinks.

1.2 SUBMITTALS

A. Product Data (PD)

1. Submit manufacturer’s literature for plumbing fixtures.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit literature and parts list.

1.4 QUALITY ASSURANCE

A. Provide plumbing fixture fittings in accordance with ASME A112.18.1 that prevent backflow from fixture into water distribution system.

B. Maintain one copy of each document on site.

PART 2 - PRODUCTS

2.1 FLUSH VALVE WATER CLOSETS

A. Manufacturers:

1. American Standard.
2. Kohler.
3. Zurn Industries.
4. Substitutions: Not Permitted.

B. Water Closet (Flush Valve):

1. Wall hung vitreous china closet with elongated rim, 1-1/2-inch (38 mm) spud, china bolt caps; 1.6 gpf flush volume.

C. Flush Valve:

1. Exposed chrome plated, battery powered, infra-red sensor operated with range adjustment and 24-hour automatic sentry flush, escutcheon, seat bumper, integral screwdriver stop and vacuum breaker.

D. Seat:

1. Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.

E. Carrier:

1. Watts Model #ISCA-101 series or #ISCA-121 series as required. Epoxy coated cast iron, 500lb static load rating, and adjustable for standard and ADA height. 16” clear chase required for back-to-back, 12” clear chase required for single.

2.2 TANK TYPE WATER CLOSETS

A. Manufacturers:

1. American Standard.
2. Kohler.
3. Zurn Industries.
4. Substitutions: Not Permitted.

B. Water Closet (Tank - Gravity Siphon Jet):

1. Kohler “Kingston” Model #K-25087, 1.28 gallon per flush two-piece, floor mount, elongated vitreous china water closet, complete with bolt caps, tank cover, and trip lever. 12” rough-in.

C. Water Closet - Accessible: (Tank – Gravity Siphon Jet)

1. Kohler “Kingston Comfort Height” Model #K-25077, ADA compliant, 1.28 gallon per flush siphon jet, 16-1/2” high, two-piece, floor mount, elongated vitreous china water closet, complete with bolt caps, tank cover, and trip lever. 12” rough-in. Order with trip lever located on the open side of the toilet for ADA compliance.

D. Seat:

1. Church Model #9500SSCT white heavy duty, solid high impact plastic, never loosens (STA-TITE) elongated open front seat less cover complete with 300 series stainless steel posts and pintles and self-sustaining check hinges.

E. Supplies:

1. McGuire Model #LFH2169-LK closet supply kit. Complete with 1/2” I.P.S. x 1/2” OD heavy pattern chrome plated brass angle stop with loose key handle, full turn brass stem, and 12” chrome plated riser.

2.3 WALL HUNG URINALS

A. Manufacturers:

1. American Standard.
2. Kohler.
3. Zurn Industries.
4. Substitutions: Not Permitted.

B. Urinal:

1. ASME A112.19.2M or ANSI Z124.9, vitreous china, wall hung urinal with shields, integral trap, 3/4 inch (19 mm) top spud, steel supporting hanger; maximum 0.5 gpf flush volume.
2. Mount accessible urinals at ADA compliant height.

C. Flush Valve:

1. Exposed chrome plated, battery powered, infra-red sensor operated with range adjustment and 24-hour automatic sentry flush, escutcheon, seat bumper, integral screwdriver stop and vacuum breaker.

D. Carrier:

1. Wade Model #402-AM1-M36 floor mounted plate type urinal carrier with rectangular uprights, upper & lower bearing plates, rectangular base feet, and flush valve support.

2.4 LAVATORIES – VITREOUS CHINA

A. Manufacturers:

1. American Standard.
2. Kohler.
3. Substitutions: Not Permitted.

B. Undermount-type Oval Lavatory:

1. Vitreous china self-rimming countertop lavatory, 17 x 14 inches, 4-inch centers, front overflow, seal of putty, caulking, or concealed vinyl gasket.

C. Wall Hung Basin – Vitreous China:

1. Vitreous china wall-hung lavatory 20 x 18 inch minimum, with drillings on 4-inch centers, rectangular basin with splash lip, front overflow.

D. Faucet and Drain:

1. ADA compliant water economy aerator with maximum 2.0 gpm (7.5 L/m) flow and indexed lever handles. Complete with grid strainer drain assembly.
2. For ADA accessible lavatories, provide offset grid drain.

E. Trap:

1. McGuire Model #8902-CNC chrome plated P-trap with 17-gauge seamless tubular chrome plated wall bend, forged brass chrome plated wall flange with setscrew, and chrome plated brass slip nuts. 1-1/4" x 1-1/2"

F. Supplies:

1. McGuire Model #LFH2165-LK-R15 lead free supply kit. Complete with chrome plated brass 1/2" I.P.S. x 3/8" OD heavy pattern angle stops with loose key handles and full turn brass stems, no plastic. Provide 15" optional riser.
2. Watts Model #LFUSG-B thermostatic mixing valve set at maximum 110°F with lead free brass body, ASSE 1070 listed, 3/8" male compression or quick connect fittings, integral check valves, integral screens and an adjustment nut with locking feature.
3. For ADA accessible lavatories, insulate hot and cold water and waste piping below lavatory with Truebro #103-EZ insulation kit.

G. Carrier (for wall hung lavatories):

1. Wade Model #W-520-08 floor mounted single lavatory carrier with concealed arms, structural steel uprights, base feet, and non-slip locking devices. Provide suffix M24 long pipe nipple to accommodate an 8" CMU wall.

2.5 LAVATORIES – STAINLESS STEEL

A. Multi-Station (not accessible):

1. Wall hung, 16-gauge Type 304 stainless steel, 48" x 17.5" Multi-Station Lavatory with two wall-mounted 2.0 gpm faucets on 10" backsplash, 1-5/8" tubular wall brackets and 2 stainless steel "Z" brackets. Complete with basket strainer. Reference Regency Tables and Sinks Item #600HSMSF1848.

B. Single Station (not accessible):

1. Wall hung, 16-gauge Type 304 stainless steel, 18" x 17.5" Single Station Lavatory with one wall-mounted 2.0 gpm faucet on 10" backsplash, 1-5/8" tubular wall brackets and 2 stainless steel "Z" brackets. Complete with basket strainer. Reference Regency Tables and Sinks Item #600HSMSF1818.

C. Drain:

1. For ADA accessible lavatories, provide offset grid drain.

D. Trap:

1. McGuire Model #8902-CNC chrome plated P-trap with 17-gauge seamless tubular chrome plated wall bend, forged brass chrome plated wall flange with setscrew, and chrome plated brass slip nuts. 1-1/2” x 1-1/2”

E. Supplies (for each faucet):

1. McGuire Model #LFH2165-LK-R15 lead free supply kit. Complete with chrome plated brass 1/2” I.P.S. x 3/8” OD heavy pattern angle stops with loose key handles and full turn brass stems, no plastic. Provide 15” optional riser.
2. Watts Model #LFUSG-B thermostatic mixing valve set at maximum 110°F with lead free brass body, ASSE 1070 listed, 3/8” male compression or quick connect fittings, integral check valves, integral screens and an adjustment nut with locking feature.
3. For ADA accessible lavatories, insulate hot and cold water and waste piping below lavatory with Truebro #103-EZ insulation kit.

2.6 SINKS – SINGLE COMPARTMENT

A. Sink: (Single Compartment)

1. Elkay Model #LR-1918, 18-gauge type 302 stainless steel sink, single compartment, 16” x 11-1/2” x 7-1/2” deep, three holes. Full undercoating. Provide model #LK-99 heavy gauge stainless steel basket strainer with 1-1/2” chrome plated brass tailpiece.

B. Faucet:

1. Delta Model #27C2942 faucet with gooseneck spout, 4” indexed wrist blade handles, and 1.5 gpm aerator.

C. Trap:

1. McGuire Model #8902-CNC chrome plated P-trap with 17-gauge seamless tubular chrome plated wall bend, forged brass chrome plated wall flange with setscrew, and chrome plated brass slip nuts. 1-1/2” x 1-1/2”

D. Supplies:

1. McGuire Model #LFH2165-LK-R15 lead free supply kit. Complete with chrome plated brass 1/2” I.P.S. x 3/8” OD heavy pattern angle stops with loose key handles and full turn brass stems, no plastic. Provide 15” optional riser.

2.7 SINKS – DOUBLE COMPARTMENT

A. Sink: (Double Compartment)

1. Elkay Model #LR3321, 18-gauge type 304 stainless steel double compartment sink with (2) 13-1/2” x 16” x 7-3/4” compartments, center drains, three holes, and sides and bottom pads for sound deadening. Provide two model #LK99 type 304 stainless steel basket strainers with 1-1/2” type 304 stainless steel tailpieces.

B. Faucet:

1. Delta Model #100LF-WF deck mounted faucet with single lever, 360-degree rotating spout, and 1.8 gpm aerator.

C. Garbage Disposal:

1. In-sink-erator “Evolution Excel”, food waste disposer, continuous feed, dual direction with 1 HP motor. 120/1/60 10.2 FLA.

D. Trap:

1. McGuire Model #8902-CNC chrome plated P-trap with 17-gauge seamless tubular chrome plated wall bend, forged brass chrome plated wall flange with setscrew, and chrome plated brass slip nuts. 1-1/2” x 1-1/2”
2. Provide 1-1/2” continuous waste.

E. Supplies:

1. McGuire Model #LFH2165-LK-R15 lead free supply kit. Complete with chrome plated brass 1/2” I.P.S. x 3/8” OD heavy pattern angle stops with loose key handles and full turn brass stems, no plastic. Provide 15” optional riser.

2.8 SHOWERS

A. Manufacturers:

1. Zurn Industries, LLC.
2. Leonard Valve.
3. Symmons Industries.
4. Substitutions: Not Permitted.

B. Shower – Non-Accessible:

1. Symmons Model #96-1-X “Temptrol” shower unit complete with pressure balancing mixing valve and service stops, Clear-Flo shower head with arm and flange, 2 gpm flow restrictor.

C. Shower – Accessible:

1. Symmons “Temptrol” Model #96-500-B30-X-L safety mix shower unit complete with pressure balancing mixing valve and service stops, Clear-Flo shower head with arm and flange, 2 gpm flow restrictor, diverter valve with integral volume control, wall/hand shower with flexible metal hose, wall connection and flange, and 24” slide bar.

D. Drain:

1. Wade Model #1100-A6-27 cast iron floor drain body with flange, integral clamping collar, seepage openings, and adjustable 6” round nickel bronze strainer. Provide deep seal trap, “Sureseal” Model #SS2009I, IAPMO listed, in-line, floor drain trap

sealer, and suffix -27 removable strainer as required by 2018 IPC 421.3. 2" drain connection.

2.9 DRINKING FOUNTAINS

A. Barrier Free – Dual Level

1. Elkay Model # EDFP217FC stainless steel dual handicapped accessible wall mounted drinking fountain with chrome plated lead-free brass bubbler with vandal resistant mounting. Provide optional Model #97258C black cane apron and Wade Model #440-AM11 water cooler carrier with pipe uprights, welded base feet, and support hardware.

2.10 ELECTRIC WATER COOLERS

A. Barrier Free - Wall Hung - Two Level

1. Elkay Model #EZSTL8SC stainless steel finished wheelchair accessible two-level unit with one-piece basins, non-pressurized cooling tank, bubbler with flexible mouth guard, and front self-closing press bars. Provide optional Model #LKAPREZL cane apron. NSF/ANSI 61 and 372 (lead free), HFC-134A refrigerant, 8.0 GPH, 370 Watts, 5.0 FLA, 115/1/60.

2.11 SERVICE SINKS

A. Service Sink:

1. Kohler "Bannon" Model #K-6714 acid resisting enameled cast iron service sink with stainless steel rim guard and wall hangers, 22" x 18".

B. Faucet:

1. Chicago Model #305-VB polished chrome plated service sink faucet. Complete with short spout with vacuum breaker, 3/4" hose thread outlet, pail hook on spout, #369 lever handles, and adjustable supply arms.

C. Trap:

1. Kohler Model #K-6673, 3" enameled inside trap standard with strainer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify adjacent construction is ready to receive rough-in work of this section.

B. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough in and installation.

3.2 INSTALLATION

A. Install each fixture with chrome plated rigid or flexible supplies with stops, reducers, and escutcheons.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

END OF SECTION 224000

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Scald protection valves.
2. Emergency showers.
3. Eyewash equipment.
4. Eye/face wash equipment.
5. Combination units.

1.2 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Portable, Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid supply.

D. Tepid: Between 60 and 100 deg F.

1.3 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit manufacturer’s literature for each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

B. Shop Drawings:

1. Plans, elevations, sections, and mounting details.
2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Emergency fixture third-party certification documentation.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ANSI/ISEA Z358.1 for emergency plumbing fixtures including third-party certification of fixtures.

B. Comply with ASSE 1071 for temperature-actuated mixing valves for plumbed emergency fixtures.

C. Comply with ASME A112.18.1/CSA B125.1 for water-supply fittings.

D. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.

E. Comply with NSF 61 and NSF 372 for fixture materials that will be in contact with potable water.

F. All exterior emergency plumbing fixtures shall be equipped with a scald protection valve to ensure the water supply temperature stays within the tepid water range (60-100 deg. F).

G. Comply with requirements in ICC A117.1 for plumbing fixtures for people with disabilities.

2.2 SCALD PROTECTION VALVE

A. Manufacturers:

1. Haws
2. Or CAWCD approved equal.

B. Setpoint:

1. Automatic thermal actuator bleed valve opens when internal temperature exceeds 95 deg. F and closes when water temperature falls below 87 deg. F.

C. Piping:

1. 1/2" NPTF inlet and outlet.

2.3 EMERGENCY SHOWERS

A. Emergency Showers - Freestanding, Plumbed:

1. Manufacturers:

a. Acorn Safety; a Division of Morris Group International
b. Bradley Corporation
c. Haws Corporation

2. Source Limitations: Obtain emergency showers, freestanding, plumbed, from single manufacturer.
3. Capacity: Not less than 20 gpm for at least 15 minutes.
4. Supply Piping: NPS 1-1/4 galvanized steel, chrome-plated brass, or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Pull rod.
6. Shower Head: 8-inch- minimum-diameter, chrome-plated brass, stainless steel, or plastic.
7. Mounting: Pedestal, accessible.

B. Emergency Showers - Off Floor, Plumbed:

1. Manufacturers:

a. Acorn Safety; a Division of Morris Group International
b. Bradley Corporation
c. Haws Corporation

2. Source Limitations: Obtain emergency showers, off floor, plumbed, from single manufacturer.
3. Capacity: Not less than 20 gpm for at least 15 minutes.
4. Supply Piping: NPS 1 galvanized steel, chrome-plated brass, or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Pull rod
6. Shower Head: 8-inch- minimum-diameter, chrome-plated brass, stainless steel, or plastic.
7. Mounting: Horizontal from wall, accessible and supported from structure.

2.4 EYEWASH EQUIPMENT

A. Eyewash Units - Standard, Freestanding, Plumbed:

1. Manufacturers:

a. Acorn Safety; a Division of Morris Group International
b. Bradley Corporation
c. Haws Corporation

2. Source Limitations: Obtain eyewash units, standard, freestanding, plumbed, from single manufacturer.
3. Capacity: Not less than 0.4 gpm for at least 15 minutes.
4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Paddle or Treadle.
6. Spray-Head Assembly: Receptor-mounted spray heads.
7. Receptor: Chrome-plated brass, stainless steel, or Plastic bowl.
8. Drain Piping:

a. Size: NPS 1-1/4 minimum.
b. Finish: Chrome-plated brass.
c. Fittings: Where connected to sewer, provide receptor drain, P-trap, waste to wall, and wall flange.

9. Mounting: Pedestal.
10. Accessories: Dust covers.

B. Eyewash Units - Accessible, Freestanding, Plumbed:

1. Manufacturers:

a. Acorn Safety; a Division of Morris Group International
b. Bradley Corporation
c. Haws Corporation

2. Source Limitations: Obtain eyewash units, accessible, freestanding, plumbed, from single manufacturer.
3. Capacity: Not less than 0.4 gpm for at least 15 minutes.
4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Paddle.
6. Spray-Head Assembly: Receptor-mounted spray heads.
7. Receptor: Chrome-plated brass, stainless steel, or Plastic bowl.
8. Drain Piping:

a. Size: NPS 1-1/4 minimum.
b. Finish: Chrome-plated brass.
c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

9. Mounting: Offset pedestal.
10. Accessories: Dust covers.

C. Eyewash Units - Standard, Wall Mounted, Plumbed:

1. Manufacturers:

a. Acorn Safety; a Division of Morris Group International
b. Bradley Corporation
c. Haws Corporation

2. Source Limitations: Obtain eyewash units, standard, wall mounted, plumbed, from single manufacturer.
3. Capacity: Not less than 0.4 gpm for at least 15 minutes.
4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Paddle.
6. Spray-Head Assembly: Two receptor-mounted spray heads.
7. Receptor: Chrome-plated brass, stainless steel, or Plastic bowl.
8. Drain Piping:

a. Size: NPS 1-1/4 minimum.

b. Finish: Chrome-plated brass.
c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

9. Mounting: Wall bracket.
10. Accessories: Dust covers.

D. Eyewash Units - Accessible, Wall Mounted, Plumbed:

1. Manufacturers:

a. Acorn Safety; a Division of Morris Group International
b. Bradley Corporation
c. Haws Corporation

2. Source Limitations: Obtain eyewash units, accessible, wall mounted, plumbed, from single manufacturer.
3. Capacity: Not less than 0.4 gpm for at least 15 minutes.
4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Paddle.
6. Spray-Head Assembly: Receptor-mounted spray heads.
7. Receptor: Chrome-plated brass, stainless steel, or Plastic bowl.
8. Drain Piping:

a. Size: NPS 1-1/4 minimum.
b. Finish: Chrome-plated brass.
c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange.

9. Mounting: Wall bracket.
10. Accessories: Dust covers.

E. Eyewash Units - Deck or Wall Mounted, Swivel Type, Plumbed:

1. Manufacturers:

a. Acorn Safety; a Division of Morris Group International
b. Bradley Corporation
c. Haws Corporation

2. Source Limitations: Obtain eyewash units, deck mounted, swivel type, plumbed, from single manufacturer.
3. Capacity: Not less than 0.4 gpm for at least 15 minutes.
4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Movement of spray-head assembly to position over sink.
6. Spray-Head Assembly: Two spray heads with offset piping.
7. Mounting: Deck mounted next to sink or deck mounted on sink.

2.5 EYE/FACE WASH EQUIPMENT

A. Eye/Face Wash Units - Standard, Freestanding, Plumbed:

1. Manufacturers:

    a. Acorn Safety; a Division of Morris Group International
    b. Bradley Corporation
    c. Haws Corporation

2. Source Limitations: Obtain eye/face wash units, standard, freestanding, plumbed, from single manufacturer.
3. Capacity: Not less than 3.0 gpm for at least 15 minutes.
4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Paddle or Treadle.
6. Spray-Head Assembly: Two or four receptor-mounted spray heads.
7. Receptor Chrome-plated brass, stainless steel, or Plastic bowl.
8. Drain Piping:

    a. Size: NPS 1-1/4 minimum.
    b. Finish: Chrome-plated brass.
    c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.

9. Mounting: Pedestal.
10. Accessories: Dust covers.

B. Eye/Face Wash Units - Accessible, Freestanding, Plumbed:

1. Manufacturers:

    a. Acorn Safety; a Division of Morris Group International
    b. Bradley Corporation
    c. Haws Corporation

2. Source Limitations: Obtain eye/face wash units, accessible, freestanding, plumbed, from single manufacturer.
3. Capacity: Not less than 3.0 gpm for at least 15 minutes.
4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Paddle.
6. Spray-Head Assembly: Two or four receptor-mounted spray heads.
7. Receptor Chrome-plated brass, stainless steel, or Plastic bowl.
8. Drain Piping:

    a. Size: NPS 1-1/4 minimum.
    b. Finish: Chrome-plated brass.
    c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.

9. Mounting: Offset pedestal.
10. Accessories: Dust covers.

C. Eye/Face Wash Units - Standard, Wall Mounted, Plumbed:

1. Manufacturers:

    a. Acorn Safety; a Division of Morris Group International
    b. Bradley Corporation
    c. Haws Corporation

2. Source Limitations: Obtain eye/face wash units, standard, wall mounted, plumbed, from single manufacturer.
3. Capacity: Not less than 3.0 gpm for at least 15 minutes.
4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Paddle.
6. Spray-Head Assembly: Two or four receptor-mounted spray heads.
7. Receptor: Chrome-plated brass, stainless steel, or Plastic bowl.
8. Drain Piping:

    a. Size: NPS 1-1/4 minimum.
    b. Finish: Chrome-plated brass.
    c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.

9. Mounting: Wall bracket.
10. Accessories: Dust covers.

D. Eye/Face Wash Units - Accessible, Wall Mounted, Plumbed:

1. Manufacturers:

    a. Acorn Safety; a Division of Morris Group International
    b. Bradley Corporation
    c. Haws Corporation

2. Source Limitations: Obtain eye/face wash units, accessible, wall mounted, plumbed, from single manufacturer.
3. Capacity: Not less than 3.0 gpm for at least 15 minutes.
4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Paddle.
6. Spray-Head Assembly: Two or four receptor-mounted spray heads.
7. Receptor: Chrome-plated brass, stainless steel, or Plastic bowl.
8. Mounting: Wall bracket.
9. Accessories: Dust covers.

E. Eye/Face Wash Units - Deck or Wall Mounted, Swivel Type, Plumbed:

1. Manufacturers:

    a. Acorn Safety; a Division of Morris Group International
    b. Bradley Corporation
    c. Haws Corporation

2. Source Limitations: Obtain eye/face wash units, deck or wall mounted, swivel type, plumbed, from single manufacturer.
3. Capacity: Not less than 3 gpm for at least 15 minutes.
4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Movement of spray-head assembly to position over sink.
6. Spray-Head Assembly: Two or four spray heads with offset piping.
7. Receptor: Chrome-plated brass, stainless steel, or Plastic bowl.
8. Mounting: Deck mounted next to sink or Deck mounted on sink.

F. Eye/Face Wash Units - Deck Mounted, Plumbed:

1. Manufacturers:

    a. Acorn Safety; a Division of Morris Group International
    b. Bradley Corporation
    c. Haws Corporation

2. Source Limitations: Obtain eye/face wash units, deck mounted, plumbed, from single manufacturer.
3. Capacity: Not less than 3 gpm for at least 15 minutes.
4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Paddle.
6. Spray-Head Assembly: Two or four spray heads.
7. Receptor: Chrome-plated brass, stainless steel, or Plastic bowl.
8. Drain Piping:

    a. Size: NPS 1-1/4 minimum.

9. Mounting: Deck.
10. Accessories: Dust covers.

2.6 COMBINATION UNITS

A. Combination Units - Emergency Shower with Eyewash, Standard, Plumbed:

1. Manufacturers:

    a. Acorn Safety; a Division of Morris Group International
    b. Bradley Corporation
    c. Haws Corporation

2. Source Limitations: Obtain combination units, emergency shower with eyewash, standard, plumbed, from single manufacturer.
3. Piping:

    a. Material: Galvanized steel, Chrome-plated brass, or stainless steel.
    b. Unit Supply: NPS 1-1/4 minimum.
    c. Unit Drain: Outlet at back or side near bottom.

4. Shower:

a. Capacity: Not less than 20 gpm for at least 15 minutes.
b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Pull rod or Treadle.
d. Shower Head: 8-inch- minimum diameter, chrome-plated brass, stainless steel, or plastic.
e. Mounting: Pedestal.

5. Eyewash Unit:

a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Spray-Head Assembly: Two receptor-mounted spray heads.
e. Receptor: Chrome-plated brass, stainless steel, or Plastic bowl.
f. Mounting: Attached shower pedestal.

B. Combination Units - Emergency Shower with Eyewash, Accessible, Plumbed:

1. Manufacturers:

a. Acorn Safety; a Division of Morris Group International
b. Bradley Corporation
c. Haws Corporation

2. Source Limitations: Obtain combination units, emergency shower with eyewash, accessible, plumbed, from single manufacturer.
3. Piping:

a. Material: Galvanized steel, Chrome-plated brass, or stainless steel.
b. Unit Supply: NPS 1-1/4 minimum.
c. Unit Drain: Outlet at back or side near bottom.

4. Shower:

a. Capacity: Not less than 20 gpm for at least 15 minutes.
b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Pull rod.
d. Shower Head: 8-inch- minimum diameter, chrome-plated brass, stainless steel, or plastic.
e. Mounting: Pedestal.

5. Eyewash Unit:

a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Spray-Head Assembly: Two receptor-mounted spray heads.
e. Receptor: chrome-plated brass, stainless steel, or plastic bowl.
f. Mounting: Attached shower pedestal.

C. Combination Units - Emergency Shower with Eye/Face Wash, Standard, Plumbed:

1. Manufacturers:

    a. Acorn Safety; a Division of Morris Group International
    b. Bradley Corporation
    c. Haws Corporation

2. Source Limitations: Obtain combination units, emergency shower with eye/face wash, standard, plumbed, from single manufacturer.
3. Piping:

    a. Material: Galvanized steel, Chrome-plated brass, or stainless steel.
    b. Unit Supply: NPS 1-1/4 minimum.
    c. Unit Drain: Outlet at back or side near bottom.

4. Shower:

    a. Capacity: Not less than 20 gpm for at least 15 minutes.
    b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
    c. Control-Valve Actuator: Pull rod or Treadle.
    d. Shower Head: 8-inch- minimum diameter, chrome-plated brass, stainless steel, or plastic.
    e. Mounting: Pedestal.

5. Eye/Face Wash Unit:

    a. Capacity: Not less than 3.0 gpm for at least 15 minutes.
    b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
    c. Control-Valve Actuator: Paddle.
    d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
    e. Receptor: chrome-plated brass, stainless steel, or plastic bowl.
    f. Mounting: Attached shower pedestal.

D. Combination Units - Emergency Shower with Eye/Face Wash, Accessible, Plumbed:

1. Manufacturers:

    a. Acorn Safety; a Division of Morris Group International
    b. Bradley Corporation
    c. Haws Corporation

2. Source Limitations: Obtain combination units, emergency shower with eye/face wash, accessible, plumbed, from single manufacturer.
3. Piping:

    a. Material: Galvanized steel, Chrome-plated brass, or stainless steel.
    b. Unit Supply: NPS 1-1/4 minimum.
    c. Unit Drain: Outlet at back or side near bottom.

4. Shower:

    a. Capacity: Not less than 20 gpm for at least 15 minutes.
    b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
    c. Control-Valve Actuator: Pull rod.

d. Shower Head: 8-inch- minimum diameter chrome-plated brass, stainless steel, or plastic.
e. Mounting: Pedestal.

5. Eye/Face Wash Unit:

a. Capacity: Not less than 3.0 gpm for at least 15 minutes.
b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
e. Receptor chrome-plated brass, stainless steel, or plastic bowl.
f. Mounting: Attached to shower pedestal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

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

3.2 INSTALLATION OF EMERGENCY PLUMBING FIXTURE

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 PIPING CONNECTIONS

A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

B. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

C. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.

D. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Emergency plumbing fixtures will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.

B. Adjust or replace fixture flow regulators for proper flow.

C. Adjust equipment temperature settings.

3.7 CLEANING AND PROTECTION

A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed emergency plumbing fixtures and fittings.

C. Do not allow use of emergency plumbing fixtures for temporary facilities unless approved in writing by CAWCD.

END OF SECTION 224500

SECTION 230503 – PIPES AND TUBES FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Pipe and pipe fittings for the following systems:

1. Heating water piping
2. Chilled water piping
3. Condenser water piping
4. Equipment drains and overflows
5. Unions and flanges
6. Gaskets for Service Piping
7. Dielectric Fittings and Couplings
8. Link Seals
9. Solder Joints for Copper Piping
10. Brazing for Copper Piping

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit data on pipe materials and fittings. Submit manufacturers' catalog information.

B. Shop Drawings (SD):

1. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

C. Quality Control Reports (QCR):

1. Welders' Certificate: Include welders' certification of compliance with ASME Section IX OR AWS B2.1.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 or ASME B31.5 code, as applicable for installation of piping systems and ASME Section IX for welding materials and procedures.

1.4 QUALIFICATIONS

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

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

B. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

C. Piping shall be stored and handled in a safe and secure manner to prevent damage from equipment, traffic, theft, and vandalism.

1.6 FIELD MEASUREMENTS

A. Verify all field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 HEATING WATER PIPING

A. Copper Tubing: ASTM B88, Type K, drawn.

1. Fittings: ASME B16.18, cast copper, or ASME B16.22 solder wrought copper.

2.2 CHILLED WATER PIPING, BURIED

A. Copper Tubing: ASTM B88, Type K annealed.

1. Fittings: ASME B16.22, solder wrought copper.

2.3 CHILLED WATER PIPING, ABOVE GROUND

A. Copper Tubing: ASTM B88, Type K, drawn.

1. Fittings: ASME B16.18, cast copper, or ASME B16.22, solder wrought copper.
2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

2.4 CONDENSER WATER PIPING, BURIED

A. Copper Tubing: ASTM B88, Type K, annealed.

1. Fittings: ASME B16.22, solder wrought copper.

2.5 CONDENSER WATER PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53/A53M, Schedule 40, galvanized.

1. Fittings: ASME B16.3, galvanized malleable iron or ASTM A234/A234M, galvanized forged steel welding type.
2. Joints: Threaded for pipe 2 inches and smaller; welded for pipe 2-1/2 inches and larger.

B. Copper Tubing: ASTM B88, Type K, drawn.

1. Fittings: ASME B16.22, solder wrought copper.
2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

2.6 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tubing: ASTM B88, Type M, drawn.

B. Fittings: ASME B16.18, cast copper, or ASME B16.22 solder wrought copper.

2.7 BACKFLOW PREVENTION

A. Provide an approved backflow prevention device as specified in Section 221119 for all systems connected to domestic water.

2.8 FITTINGS, UNIONS, AND FLANGES FOR COPPER PIPING:

A. Unless otherwise specified for copper piping, comply with the following requirements.

B. Tube Fittings:

1. Solder Joint Fittings: ASME B16.18 cast copper, or ASME B16.22 wrought copper.
2. Elbows 4" and smaller shall be long radius, unless approved otherwise by CAWCD.
3. Threaded ends shall conform to ASME B1.20.1.

C. Unions: For NPS 2" and smaller, ASME B16.22 wrought or ASME B16.18 cast, copper alloy body, hexagonal stock, metal-to-metal seating surfaces, and solder-joint ends.

D. Flanges: For NPS 2-1/2" and larger, ASTM B584 Bronze Alloy, Class 150, flat-face type, drilled to ASME B16.5, and solder-joint ends.

2.9 GASKETS FOR SERVICE PIPING:

A. Gasket dimensions and materials shall conform to ASME B16.21.

B. Gaskets for cold working pressure (CWP) equal to and less than 250 psig, temperatures equal to and less than 250°F.

1. Gasket Material:

a. Neoprene elastomer with minimum Shore A hardness value of 80.
b. Thickness: Minimum 3/32-inch thick for 1-inch pipe and smaller and minimum 1/8-inch thick for pipe larger than 1-inch.

2. Manufacturers:

a. Garlock, Style 7797.
b. John Crane, similar product.

C. Gaskets for CWP equal to and less than 150 psig, temperatures equal to and less than 160°F.

1. Gasket Material:

a. Neoprene elastomer, compressed, non-asbestos fiber reinforcement.

2. Manufacturers:

a. Garlock, Blue-Gard, Style 3300.
b. John Crane, similar product.

2.10 DIELECTRIC FITTINGS AND COUPLINGS FOR SERVICE PIPING:

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

B. Dielectric Unions:

1. Manufacturers:

a. A.Y. McDonald Mfg. Co.
b. Capitol Manufacturing Company.
c. Hart Industries International, Inc.
d. Watts Regulator Co.
e. Zurn Industries, LLC.

2. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 150 psig at 180 deg F.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers:

a. Capitol Manufacturing Company.
b. Watts Regulator Co.
c. Zurn Industries, LLC.

2. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: 150 psig at 180 deg F.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers:

a. Grinnell Mechanical Products.
b. Precision Plumbing Products, Inc.

2. Description:

a. Standard: IAPMO PS 66.
b. Electroplated steel nipple, complying with ASTM F1545.
c. Pressure Rating: 300 psig at 225 deg F.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

2.11 LINK TYPE SEALS:

A. Manufacturers:

1. Calpico, Inc.

2. Thunderline Corporation, Link-Seal.

B. Characteristics:

1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
2. Assemble links solely with stainless steel bolts and nuts to form a continuous rubber belt around the pipe.
3. Provide a stainless steel or glass reinforced nylon pressure plate under each bolt head and nut. Isolate pressure plate from contact with wall sleeve.
4. Stainless steel hardware. No exceptions.

2.12 SOLDER JOINTS FOR COPPER PIPING:

A. Solder: ASTM B32, Alloy Grade Sn95 tin-silver, lead-free solder Stay-Brite ® 8

B. Flux: ASTM B813, Liquid or Paste type, water flushable.

C. No substitutions unless approved otherwise by CAWCD.

2.13 BRAZING FOR COPPER PIPING:

A. Braze Joints:

1. Brazing alloys shall have melting points above 1000 F (538 C), (ASME B31.2; NFPA 31, 51, 58).
2. Silver brazing alloy shall be AWS A5.8 classification BCUP-5, containing 15 percent silver, 80 percent copper, and 5 percent phosphorous.
3. Flux: AWS Standard A5.21, Type FB3-A or FB3-C.
4. Pipe and fittings charred or collapsed due to excessive heating will not be permitted and shall be removed from the job site.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify excavations are to required grade, dry, and not over-excavated.

B. Verify trenches are ready to receive piping.

3.2 PREPARATION

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

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

A. Verify connection to existing piping system (if applicable), size, location, and invert are as indicated on Drawings.

B. Establish minimum separation of all underground utilities in accordance with latest adopted CAWCD building codes.

C. Install pipe to elevation as indicated on Drawings.

D. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.

E. Install pipe on prepared bedding.

F. Route pipe in straight line.

G. Install pipe to allow for expansion and contraction without stressing pipe or joints.

H. Install shutoff and drain valves at locations indicated on Drawings.

I. Install plastic ribbon tape/ trace wire per Section 220553.

J. Install buried pipe insulation per Section 230700.

K. Pipe Cover and Backfilling:

1. Maintain optimum moisture content of fill material to attain required compaction density.
2. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 4-inches compacted layers to 6-inches minimum cover over top of jacket. Compact to 95 percent maximum density.
3. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
4. Do not use wheeled or tracked vehicles for tamping.

3.4 INSTALLATION - ABOVE GROUND PIPING

A. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

B. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.

C. Group piping whenever practical at common elevations.

D. Sleeve pipe passing through partitions, walls and floors.

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

F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not accessible.

H. Install non-conducting dielectric connections wherever joining dissimilar metals.

I. Establish invert elevations, slopes for drainage to 1/4-inch per foot minimum. (1/8-inch per foot minimum in cases 1/4- inch cannot be met and CAWCD approves). Maintain gradients.

J. Slope piping and arrange systems to drain at low points.

K. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

L. Install piping penetrating roofed areas to maintain integrity of roof assembly.

M. Install hangers and supports per Section 230529.

N. Install above ground pipe insulation per Section 230700.

3.5 INSTALLATION - HEATING AND COOLING PIPING SYSTEMS

A. Install condenser water piping in accordance with ASME B31.9.

B. Install heating water and chilled water piping in accordance with ASME B31.9.

3.6 WALL AND SLAB PENETRATIONS

A. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, pilasters, columns, piers, and beams unless specified or otherwise indicated on the Drawings.

B. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping.

1. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
2. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
3. Seal spaces between pipes and sleeves with link-type seals for all water piping size 2 inches and above.

C. Cast couplings or wall pieces in walls for penetrations of buried rigid piping including cast iron, ductile iron, and reinforced concrete, through structures.

1. Provide couplings or wall pieces with mechanical push-on's or similar flexible joints at outside faces of walls.
2. Provide additional similar joints in piping at transition points between trenches and structure excavations.
3. For steel piping, single joints may be used in lieu of 2 joints. Locate single joints outside within 2 feet from outside faces of walls.
4. Link Seal: Use 2 link seals where seal is used to seal at wet wall sleeves. Mount one seal on the inside face of the wall and the other on the outside face of the wall. Coordinate the inside diameter of the wall sleeve with the size of the seal to provide watertight sealing.

3.7 WALL AND SLAB PENETRATIONS FOR FIRE-RESISTANCE RATED ASSEMBLIES

A. Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire-stop and/or smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078400.

3.8 FIELD QUALITY CONTROL

A. Test heating water piping system, chilled water piping system, and condenser water piping system in accordance with ASME B31.9.

B. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by CAWCD.
b. During installation, notify CAWCD at least one day before inspection must be made. Perform tests specified below in presence of CAWCD:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for CAWCD to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Re-inspection: If CAWCD finds that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
d. Reports: Prepare inspection reports and have them signed by CAWCD.

2. Piping Tests for Water Service, Drain and Vent Service Piping:

a. Fill piping with water. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

c. Leave new, altered, extended, or replaced water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject water service piping to static pressure of 1.5 X CWP, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Subject drain and vent piping to static water pressure equal to DH. Isolate test source and allow it to stand for four hours. Leaks and loss in water level constitute defects that must be repaired.
f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
g. Prepare reports for tests and for corrective action required.

C. Piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 CLEANING

A. After completion, fill, clean, and treat the heating water piping system, chilled water piping system, and condenser water piping system. Refer to Section 232500 for cleaning procedures.

3.10 PIPING SCHEDULE

System	System / Description	Performance Requirements		Service	Type
		CWP (psig)	(°F)		
NCH	Chilled Water	150	200	Water	Drawn Copper, Type K
NCH	Chilled Water / Condensate-Drain	DH	150	Drain and Vent	Drawn Copper, Type M
NCH	Chilled Water / Blowdown-Drain	DH	200	Drain and Vent	Drawn Copper, Type M
NCH	Chilled Water / Air-Vent Piping	DH	200	Drain and Vent	Drawn Copper, Type M
NH	Heating Water	150	200	Water	Drawn Copper, Type K
PSW	Plant Service Water	80	120	Water	Drawn Copper, Type K

PDW	Plant Domestic Water / Makeup-Water	80	120	Water	Drawn Copper, Type K
PSA	Plant Service Air	150	200	Air	Drawn Copper, Type K
PRW	Plant Raw Water	100	120	Water	Drawn Copper, Type K

END OF SECTION 230503

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes single- and three-phase motors for application on HVAC equipment provided under other sections.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

B. Test Reports (TR):

1. Indicate procedures and results for specified factory and field testing and inspection.

C. Operations and Maintenance Data:

1. Include in final O&M Manuals provided to CAWCD.

1.3 QUALIFICATIONS

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

B. Testing Agency: Company shall be member of International Electrical Testing Association and specialize in testing products specified in this section with minimum three years documented experience.

C. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

B. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.

C. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

A. Motors 3/4 hp and Larger: Three-phase motor as specified below.

B. Motors Smaller Than 3/4 hp: Single-phase motor Electronically commutated motor (ECM) as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.

C. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods.

1. Voltage: volts, three phase, 60 Hz.
2. Service Factor: 1.25.
3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
5. Insulation System: NEMA Class F.
6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
9. Sound Power Levels: Conform to NEMA MG 1.
10. Motors Used with Variable Frequency Drives: Premium efficiency, inverter-duty motors. Motor frequency shall not exceed 90 Hz.

D. Single Phase Motors:

1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
2. Voltage: 115, 208, 230, or 460 volts, single phase, 60 Hz.

E. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts 120 V or 240 V single-phase AC power to three-phase DC power to operate brushless DC motor.
2. Three-phase power module with permanent magnet rotor.
3. Digital speed controller.
4. Building Automation System Interface: Via DC voltage signal.

F. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 SOURCE QUALITY CONTROL

A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 - EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned motors.

B. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.

C. Clean and repair existing motors to remain or are to be reinstalled.

3.2 INSTALLATION

A. Install securely on firm foundation. Mount ball bearing motors in accordance with motor manufacturer's requirements.

B. Install engraved plastic nameplates.

C. Motors shall be grounded and bonded.

3.3 FIELD QUALITY CONTROL

A. Field inspecting, testing, adjusting, and balancing per Section 230593.

B. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION 230513

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.
4. Globe Valves.
5. OS&Y Gate Valves.
6. Chainwheels.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

1.3 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit manufacturer's catalog information with valve data and ratings for each service.

B. Manufacturer's Installation Instructions:

1. Submit hanging and support methods, joining procedures.

C. Coordination Drawings:

1. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

D. Operation and Maintenance Data:

1. Include in final O&M Manuals provided to CAWCD.

1.4 QUALITY ASSURANCE

A. For drinking water service, provide valves complying with NSF 61.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

C. ASME B31.1 for service piping and equipment.

1.5 QUALIFICATIONS

A. Manufacturer:

1. Company specializing in manufacturing Products specified in this section with minimum five years documented experience.
2. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Provide temporary protective coating on cast iron and steel valves if required.
4. Set globe valves closed to prevent rattling.
5. Set ball valves open to minimize exposure of functional surfaces.
6. Set butterfly valves closed or slightly open.
7. Block check valves in either closed or open position.

B. Use the following precautions during storage:

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

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

B. Valves 2 inch and smaller shall be ball type.

C. Valves 2-1/2 inch and larger shall be butterfly type.

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

E. Substitutions: Permitted as approved by CAWCD

F. Valve Actuator Types:

1. Handwheel: For valves other than quarter-turn types.
2. Hand Lever: For quarter-turn valves NPS 6 and smaller.
3. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

G. Valves in contact with domestic water systems shall be certified to NSF/ANSI 61 Annex F & G, and NSF/ANSI 372.

H. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: With extended neck.
3. OS&Y Gate Valves: With extended stem that allows clearance for valve operation without breaking or disturbing insulation.

I. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.
4. Press Connect: With press connect according to ASME B16.51.
5. Non-flanged valves shall have union fittings installed upstream and downstream to add orientation and removal for maintenance.

a. Exception: 3-piece threaded valves do not require additional union fittings.

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

2.2 BALL VALVES

A. Bronze Ball Valves:

1. Manufacturers:

a. NIBCO INC.
b. Milwaukee Valve Company.
c. Conbraco Industries, Inc.; Apollo Valves.
d. Crane Co.; Crane Valve Group; Crane Valves.
e. WATTS; A Watts Water Technologies Company.

2. BA-1 NPS 2 inches and Smaller: MSS SP 110, Class 150, 150 SWP, 600 CWP, two-piece bronze body, stainless steel trim, full port, teflon seats, blow-out proof stem, soldered or threaded ends, lever handle with balancing stops.

3. BA-2 NPS 2-1/2 inches to NPS 4 inches: MSS SP 110, Class 150, 150 SWP, 400 CWP, two-piece bronze body, stainless steel trim, conventional-port, teflon seats, blow-out proof stem, threaded ends, lever handle with balancing stops.

2.3 BUTTERFLY VALVES

A. Iron Butterfly Valves:

1. Manufacturers:

   a. Bray Controls; a division of Bray International.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Mueller Steam
   h. WATTS; A Watts Water Technologies Company.

2. BF-1 NPS 2-1/2 inches and Larger: MSS SP 67, 200 CWP, Body**:** A126 Cast iron or A536 ductile iron, lug type, stainless steel stem, Disc: Aluminum bronze, Seat: Molded in EPDM.
3. Handle and Operator:

   a. 6 inches and smaller: Provide 10 position lever handle for throttling applications only.
   b. 8 inches and larger: Provide gear operators.

2.4 CHECK VALVES

A. Bronze Swing Check Valves:

1. Manufacturers:

   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. WATTS; A Watts Water Technologies Company.

2. CK-1 MSS SP 80 Type 3, Class 125, 200 CWP, Horizontal Flow, bronze body, bronze disc, teflon seat, threaded ends.

B. Iron Swing Check Valves with Closure Control:

1. Manufacturers:

   a. Crane Co.
   b. NIBCO INC.

2. CK-2 NPS 2-1/2 inches to NPS 12 inches: MSS SP 71, Class 125, 200 CWP, Clear or full waterway body design, ASTM A126 cast iron body, bronze swing disc, renewable disc seal and seat, asbestos free gaskets, and flanged ends.

C. Double Check Valve, Backflow Prevention Assemblies:

1. Manufacturers:

a. Crane Fluid Systems; Crane Co.
b. WATTS; A Watts Water Technologies Company.
c. Zurn Industries, LLC

2. CK-3 ASSE 1015, NSF 372, and NSF 61 compliant. NPS 2 inches and smaller: bronze body with ball valve on inlet and outlet, test cocks, and max 5 psig pressure drop through design flow rate.

D. Center-Guided, Spring-Loaded Check Valves: (Silent Check Valves)

1. Manufacturers:

a. Flomatic Valves; Flomatic Corporation.
b. WATTS; A Watts Water Technologies Company.
c. Milwaukee Valve Company
d. NIBCO INC.

2. CK-4 MSS SP 125, Class 125, 200 CWP, ASTM A126 gray iron body, spring loaded globe style with bronze seat and flanged ends.

2.5 GLOBE VALVES

A. Bronze Globe Valves:

1. Manufacturers:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. Milwaukee Valve Company.
d. NIBCO INC.

2. GB-1 MSS SP 80 Type 1, 300 CWP, ASTM B 62 bronze body with integral seat and screw-in or union bonnet, Asbestos free packing, malleable iron handwheel.

2.6 OS&Y GATE VALVES

A. Iron OS&Y Gate Valves:

1. Manufacturers:

a. Crane Fluid Systems; Crane Co.
b. Milwaukee Valve Company.
c. WATTS; A Watts Water Technology Company.

d. NIBCO INC.

2. MSS SP 70 Type 1, Class 125, 200 CWP, ASTM A 126 gray iron body with bolted bonnet, bronze trim, solid wedge disc, and Asbestos free packing.

2.7 CHAINWHEELS

A. Manufacturers:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description:

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to butterfly valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 VALVE INSTALLATION

A. Install valves with stems upright or horizontal, not inverted. Install valves in horizontal piping with stem at or above center of pipe.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown. Locate valves for easy access and provide separate support where necessary. Valves shall be no more than 6 feet above floor unless otherwise approved by CAWCD.

C. Install valves with clearance for installation of insulation and allowing access.

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

E. Install 3/4-inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

F. Install chain wheels on operators for isolation valves more than 96 inches above floor. Extend chains to 60 inches above finished floor.

G. Install swing check valves for proper direction of flow, in horizontal position with hinge pin level.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. Install valves at locations indicated on Drawings and according to this Section.

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

1. Shutoff Service: Ball, butterfly valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: ball, or butterfly valves.
4. Pump-Discharge Check Valves:

    a. NPS 2-1/2 and Larger: Iron swing check valves.

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

D. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.

3.5 HVAC VALVE SCHEDULE

A. See Special Provisions or Project Drawings for valve schedule.

END OF SECTION 230523

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment Nameplates.
2. Pipe labels.
3. Valve tags.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. For each type of product, submit manufacturers catalog literature.

B. Shop Drawings (SD):

1. Samples: For color, letter style, and graphic representation required for each identification material and device.
2. Equipment-Nameplate Schedule: Include a listing of all equipment to be labeled with the proposed content for each nameplate.
3. Valve-numbering scheme.
4. Valve Schedules: Provide for each piping system. Include in operation and maintenance manuals.
5. Each schedule shall include equipment identification including wording, symbols, letter size, and color coding.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.4 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 EQUIPMENT NAMEPLATES

A. Manufacturers:

1. Brimar Industries Inc.
2. Seton Identification Products.
3. Or Equal.

B. Nameplate Size: Sized to fit text, but not less than 1” high by 3” wide. Minimum letter size of 1/4" for name of units if viewing distance is less than 24”, 1/2” for viewing distances up to 72” and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of the principal lettering.

C. Label per equipment schedule.

D. Indoor Nameplates:

1. Material: 1/16” thick, 2-layer, Rigid Phenolic Plastic, per ASTM D709 Type 1.
2. Color Scheme: Engraved white letters on black contrasting background, unless specified otherwise in project documents.
3. Mounting: Two 3/16” diameter mounting holes and/or adhesive backing.

E. Outdoor Nameplates:

1. Material: 22 gauge engraved stainless steel or brass.
2. Color Scheme: Engraved letters, black filled, unless specified otherwise in project documents.
3. Mounting: Two 3/16” diameter mounting holes and/or adhesive backing.

2.2 VALVE TAGS

A. Manufacturers:

1. Brady.
2. Brimar Industries Inc.
3. Seton Identification.
4. Or Equal.

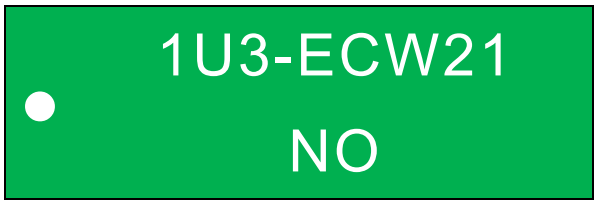
B. Valve Tag Size: 1 inch high by 3 inches wide.

C. Label per approved valve schedule. Valve tags shall be 2-line unless approved otherwise:

1. Line 1: Valve ID Number, example “1U3-ECW21”.

a. Note: 1U3-ECW21 = level 1, Unit 3, Emergency Cooling Water System, Valve Number 21.

2. Line 2: Valve Normal operating position, either “NO” – normally open, “NC” – normally closed, “AUTO” – for an automatically operated valve, or “PRV” – for pressure relief valves.
3. Example Tag:



D. Indoor Valve Tags:

1. Material: 1/16” thick, 2-layer, Rigid Phenolic Plastic, per ASTM D709 Type 1.
2. Color Scheme: Engraved white letters on contrasting background per pipe identification schedule in article 3.3 (based on system service), unless specified otherwise in project documents.
3. Mounting: One 3/16” diameter mounting hole on left side of tag, for use with 1/16” Stainless-steel cable w/ ferrule, length as needed to attach to valve.

E. Outdoor Valve Tags:

1. Material: 22 gauge engraved stainless steel or brass.
2. Color Scheme: Engraved letters, black filled, unless specified otherwise in project documents.
3. Mounting: One 3/16” diameter mounting hole on left side of tag, for use with 1/16” Stainless-steel cable w/ ferrule, length as needed to attach to valve.

2.3 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Manufacturers:

1. Brady.
2. Seton Identification.
3. Or Equal.

C. Product Description

1. Plastic Pipe Markers - Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener. Minimum letter size of 1-1/2 inch.
2. Plastic Tape Pipe Markers - Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Minimum letter size of 1-1/2 inch.
3. Plastic Underground Pipe Markers: - Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
4. Pipe Markers shall indicate the following:

    a. System.

b. Pipe size.
c. Flow direction.

2.4 EQUIPMENT INFORMATION AND WARNING LABELS

A. Manufacturers:

1. Brady.
2. Seton Identification Products.
3. Or Equal.

B. Product Description: Aluminum, Polyester, or Laminated Mylar, size 1.9 x 0.75 inches (48 x 19 mm), adhesive backed with printed identification.

C. Color scheme shall be per ANSI Z535 for safety signs related to piping and plumbing equipment.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION, GENERAL REQUIREMENTS

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

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

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

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

3.3 INSTALLATION OF EQUIPMENT NAMEPLATES AND WARNING SIGNS

A. Permanently fasten nameplates on each item of mechanical equipment.

B. Locate equipment nameplates where accessible and visible.

3.4 INSTALLATION OF PIPE LABELS

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

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

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

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

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

3.5 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Colors:

1. For each piping system, use the same lettering and background coloring system on valve tags as used for the Pipe Label Schedule text and background.

3.6 SCHEDULES

A. Pipe Identification

Service	**Description**	**Letter Color**	**Background Color**
ACBA	Airblast Circuit Breaker Air	White	Blue
AC	Air Chamber	White	Blue
ACR	Air Compressor Room	White	Blue
AV	Air Vent (Vacuum)	White	Blue
BA	Break Air	White	Blue

Service	Description	Letter Color	Background Color
BM	Black Mountain Discharge Pipeline	White	Green
CBA	Circuit Breaker Air	White	Blue
CBP	CAP Bypass	White	Green
CL	Chlorination System	Black	Orange
CLW	Chlorinated Water	White	Green
CO2	Carbon Dioxide	White	Red
DLF	Discharge Line Fill	White	Green
DHW	Discharge Header Water	White	Green
DO	Drip Oil	White	Brown
DPA	Depressing Air	White	Blue
DV	Discharge Valve Air	White	Blue
DVB	Discharge Valve Bypass	White	Green
DVHO	Discharge Valve Hydraulic Oil	White	Brown
DVOA	Discharge Valve Operating Air	White	Blue
DW	Domestic Water	White	Green
ECW	Emergency Cooling Water	White	Green
ECW	HVAC Evaporative Cooling Water	White	Green

Service	Description	Letter Color	Background Color
EG	Emergency Generator Fuel	Black	Yellow
ETV	Equalizing Tube Air Vent	White	Green
FCHO	Fixed Cone Hydraulic Oil	White	Brown
FSW	Fire Suppression Water	White	Red
GOA	Governor Operating Air	White	Blue
GOHO	Governor Hydraulic Oil	White	Brown
HLO	High Pressure Lube Oil	White	Brown
JGHO	Jet Gate Hydraulic Oil	White	Brown
JHO	Jacking Hoist/Hydraulic Oil	White	Brown
JLO	Jacking Lube Oil	White	Brown
LCIC	LCI Drive Coolant System	White	Green
LO	Lube Oil	White	Brown
MBA	Motor Brake Air	White	Blue
MSW	Mechanical Seal Water	White	Blue
NCH	Chilled Water	White	Green
NHW	Heating Hot Water	White	Green

Service	Description	Letter Color	Background Color
NCW	Condenser Water	White	Green
NSW	HVAC Service Water	White	Green
OFW	Oil Storage Fire Water	White	Red
OGHO	Outlet Gates Hydraulic Oil	White	Brown
OFP	Oil Storage Room Fire Protection	White	Red
OWF	Outlet Works Fill	White	Green
OWSW	Outlet Works Service Water	White	Green
PDW	Plant Domestic & Service Water	White	Green
PFP	Plant Fire Protection	White	Red
POT	Potable Water System	White	Green
PPW	Pump Packing Water	White	Green
PSA	Plant Service Air	White	Blue
PSE	Pneumatic Sewage Ejection	White	Green
PSI	Plant Sump Inlet	White	Green
PRW	Plant Raw Water	White	Green
PSW	Plant Service Water (Strainer)	White	Green

Service	Description	Letter Color	Background Color
PWS	Plant Water Systems Supply	White	Green
PZ	Piezometer	White	Green
RLI	River Outlet Lake Indication	White	Green
SBW	Stuffing Box Water	White	Green
SD	Sludge Water	White	Green
SE	Sewage Ejection	White	Green
SFC	Sand Filter Control	White	Green
SFE	Sand Filter Water	White	Green
SGHO	Slide Gate Hydraulic Oil	White	Brown
SO	Sump Oil	White	Brown
SRS	Sewage Removal System	White	Green
SSO	Service Seal Oil	White	Brown
SSW	Shaft Seal Water	White	Green
STA	Sewage Treatment Air	White	Blue
STF	Suction Tube Fill	White	Green
ST	Surge Tank	White	TBD
SWO	Sump Waste Oil	White	Brown

Service	Description	Letter Color	Background Color
TFW	Transformer Fire Water	White	Red
TRG	Trash Rake Gearbox	White	Green
U	Unit Bay	White	Green
UCW	Unit Cooling Water	White	Green
UD	Unit Discharge	White	Green
UW	Unwatering	White	Green
UWS	Unwatering System	White	Green
VHO	Valve Hydraulic Oil	White	Brown
VOA	Valve Operating Air	White	Blue
VOS	Discharge Valve Operating	White	Green
WD	Water Delivery	White	Green
WO	Waste Oil	White	Brown
WQM	Water Quality Monitoring System	White	Green
WGHO	Wheelgate Hydraulic Oil	White	Brown

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing, adjusting, and balancing of air systems.
2. Testing, adjusting, and balancing of hydronic and refrigerating systems.
3. Measurement of final operating condition of HVAC systems.
4. Sound measurement of equipment operating conditions.
5. Vibration measurement of equipment operating conditions.

1.2 ACTION SUBMITTALS

A. Qualification data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this project's TAB members meet the qualifications specified in Section 1.4 – Quality Assurance. TAB Contractor to be separate entity from installing contractor as well as Commissioning Agency.

B. Strategies and Procedures Plan: Submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty or Copy of NEBB Certificate of Conformance Certification. Written procedures must be project specific tailored to this specific project.

C. Instrument calibration reports: Submit proof of latest calibration date of each instrument.

D. Final Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms or NEBB Report forms.

1. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
2. Furnish reports in letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings (11x17) with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations. Also provide soft copy reports to CAWCD in PDF format.

a. The schematic drawings provided must be the schematic diagrams of systems "as-built" conditions. Verify "as-built" conditions are properly documented prior to performing balancing.

E. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance OR NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

B. Engage a TAB entity certified by AABC or NEBB.

C. Maintain one copy of each document on site.

D. Prior to commencing Work, calibrate each instrument to be used.

E. HVAC Commissioning Agent (Section 230800) to oversee all TAB work taking place. TAB Contractor to schedule all work with Commissioning Agent for witnessing of testing.

1.4 QUALIFICATIONS

A. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor.

1.5 SEQUENCING

A. Sequence balancing between completion of systems tested and Date of Substantial Completion.

B. Perform balancing after leakage and pressure tests on air distribution systems have been satisfactorily completed.

C. HVAC Controls System shall be fully functional, tested, commissioned, and accepted by CAWCD prior to Test and Balance.

1.6 SCHEDULING

A. Full CAWCD Occupancy: CAWCD will occupy the site and existing building during entire balancing period. Cooperate with CAWCD during balancing operations to minimize conflicts with CAWCD's operations.

B. Schedule and provide assistance in final adjustment and test of life safety system with CAWCD HVAC and Fire Personnel.

C. HVAC Commissioning Agent (Section 230800) to oversee all TAB work taking place. TAB Contractor to schedule all work with Commissioning Agent for witnessing of testing.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify systems are complete and operable before commencing work. Verify the following:

1. Systems are started and operating in safe and normal condition.
2. HVAC control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed, and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place or in normal position.
15. Service and balancing valves are open.

B. Report deficiencies discovered before and during TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Furnish instruments required for testing, adjusting, and balancing operations.

B. Make instruments available to CAWCD to facilitate spot checks during testing.

C. Field verify prior to balancing that there is adequate access to perform the balancing work required. It is the responsibility of the balancing company to identify access issues prior to performing balancing testing. The General Contractor is responsible for ensuring the installation allows the testing agency to perform their required testing.

3.3 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.4 ADJUSTING

A. Verify recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.

D. Report defects and deficiencies noted during performance of services, preventing system balance.

E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

F. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.

G. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 HVAC CONTROLS VERIFICATION

A. Verify HVAC control system is operating within the design limitations.

B. Confirm that the sequences of operation are in compliance with Contract Documents.

C. Verify that controllers are calibrated and function as intended.

D. Verify that controller set points are as indicated.

E. Verify the operation of lockout or interlock systems.

F. Verify the operation of valve and damper actuators.

G. Verify that controlled devices are properly installed and connected to correct controller.

H. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.

I. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

3.6 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.

B. Make air flow rate measurements in main ducts by Pitot tube traverse of entire cross-sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.

E. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.

F. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

G. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

J. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.

K. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

L. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.

M. On fan powered VAV boxes, adjust airflow switches for proper operation.

N. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

3.7 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.

8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

3.8 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.9 WATER SYSTEM PROCEDURE

A. Adjust water systems, after air balancing, to obtain design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.

C. Confirm air bleeds indicate system is full of water.

D. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

E. Perform system balance with automatic control valves fully open triple duty valves fully open, and pump VFDs at 100 percent speed.

F. Confirm pump rotation and differential pressure at full flow.

G. Perform adjustment of water distribution systems by the following measures:

1. Reduce total system flow rate first by reducing speed of VFD.

2. Use balancing cocks, valves, and fittings.

H. Do not use service or shut-off valves for balancing unless designed for balancing and shut-off functions. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

3.10 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:

1. Fire Pumps
2. Plumbing Pumps
3. HVAC Pumps
4. Water Tube Boilers
5. Reciprocating Water Chillers
6. Air Cooled Water Chillers
7. Centrifugal Water Chillers
8. Absorption Water Chillers
9. Induced Draft Cooling Tower
10. Blow Through Cooling Tower
11. Air Cooled Refrigerant Condensers
12. Packaged Roof Top Heating/Cooling Units
13. Packaged Terminal Air Conditioning Units
14. Unit Air Conditioners
15. Computer Room Air Conditioning Units
16. Air Coils
17. Evaporative Humidifier
18. Terminal Heat Transfer Units
19. Induction Units
20. Unit Ventilators
21. Fan Coil Units
22. Air Handling Units
23. Fans
24. Air Filters
25. Air Terminal Units
26. Air Inlets and Outlets
27. Heat Exchangers

B. Report Forms

1. Title Page:

a. Name of Testing, Adjusting, and Balancing Agency
b. Address of Testing, Adjusting, and Balancing Agency
c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
d. Certification sheet, signed and sealed by the certified testing and balancing engineer.
e. Project name
f. Project location

g. Project Architect
h. Project Engineer
i. Project Contractor
j. Project altitude
k. Report date

2. Table of contents with the total number of pages defined for each section of the report. Number each page in the report.
3. Summary Comments:

    a. Design versus final performance
    b. Notable characteristics of system
    c. Description of systems operation sequence
    d. Summary of outdoor and exhaust flows to indicate building pressurization
    e. Nomenclature used throughout report
    f. Test conditions

4. Instrument List:

    a. Instrument
    b. Manufacturer
    c. Model number
    d. Serial number
    e. Range
    f. Calibration date

5. Electric Motors:

    a. Manufacturer
    b. Model/Frame, Serial #
    c. HP/BHP and kW
    d. Phase, voltage, amperage; nameplate, actual, no load
    e. RPM
    f. Service factor
    g. Starter size, rating, heater elements
    h. Sheave Make/Size/Bore

6. V-Belt Drive:

    a. Identification/location
    b. Required driven RPM
    c. Driven sheave, diameter and RPM
    d. Belt size and quantity
    e. Motor sheave diameter and RPM
    f. Center to center distance, maximum, minimum, and actual

7. Pump Data:

    a. Identification/number
    b. Manufacturer
    c. Size/model
    d. Impeller

e. Service
f. Design flow rate, pressure drop, BHP and kW
g. Actual flow rate, pressure drop, BHP and kW
h. Discharge pressure
i. Suction pressure
j. Total operating head pressure
k. Shut off, discharge and suction pressures
l. Shut off, total head pressure

8. Air Cooled Condenser:

a. Identification/number
b. Location
c. Manufacturer
d. Model number
e. Serial number
f. Entering DB air temperature, design and actual
g. Leaving DB air temperature, design and actual
h. Number of compressors

9. Chillers:

a. Identification/number
b. Manufacturer
c. Capacity
d. Model number
e. Serial number
f. Evaporator entering water temperature, design and actual
g. Evaporator leaving water temperature, design and actual
h. Evaporator pressure drop, design and actual
i. Evaporator water flow rate, design and actual
j. Condenser entering water temperature, design and actual
k. Condenser pressure drop, design and actual
l. Condenser water flow rate, design and actual

10. Cooling Tower:

a. Tower identification/number
b. Manufacturer
c. Model number
d. Serial number
e. Rated capacity
f. Entering air WB temperature, specified and actual
g. Leaving air WB temperature, specified and actual
h. Ambient air DB temperature
i. Condenser water entering temperature
j. Condenser water leaving temperature
k. Condenser water flow rate
l. Fan RPM

11. Heat Exchanger:

a. Identification/number
b. Location
c. Service
d. Manufacturer
e. Model number
f. Serial number
g. Steam pressure, design and actual
h. Primary water entering temperature, design and actual
i. Primary water leaving temperature, design and actual
j. Primary water flow, design and actual
k. Primary water pressure drop, design and actual
l. Secondary water leaving temperature, design and actual
m. Secondary water leaving temperature, design and actual
n. Secondary water flow, design and actual
o. Secondary water pressure drop, design and actual

12. Cooling Coil Data:

    a. Identification/number
    b. Location
    c. Service
    d. Manufacturer
    e. Air flow, design and actual
    f. Entering air DB temperature, design and actual
    g. Entering air WB temperature, design and actual
    h. Leaving air DB temperature, design and actual
    i. Leaving air WB temperature, design and actual
    j. Water flow, design and actual
    k. Water pressure drop, design and actual
    l. Entering water temperature, design and actual
    m. Leaving water temperature, design and actual
    n. Saturated suction temperature, design and actual
    o. Air pressure drop, design and actual

13. Heating Coil Data:

    a. Identification/number
    b. Location
    c. Service
    d. Manufacturer
    e. Air flow, design and actual
    f. Water flow, design and actual
    g. Water pressure drop, design and actual
    h. Entering water temperature, design and actual
    i. Leaving water temperature, design and actual
    j. Entering air temperature, design and actual
    k. Leaving air temperature, design and actual
    l. Air pressure drop, design and actual

14. Electric Duct Heater:

    a. Manufacturer

b. Identification/number
c. Location
d. Model number
e. Design kW
f. Number of stages
g. Phase, voltage, amperage
h. Test voltage (each phase)
i. Test amperage (each phase)
j. Air flow, specified and actual
k. Temperature rise, specified and actual

15. Induction Unit Data:

a. Manufacturer
b. Identification/number
c. Location
d. Model number
e. Size
f. Design air flow
g. Design nozzle pressure drop
h. Final nozzle pressure drop
i. Final air flow

16. Unit Ventilator and Fan Coil Data:

a. Manufacturer
b. Identification/number
c. Location
d. Model number
e. Size
f. Air flow, design and actual
g. Water flow, design and actual
h. Water pressure drop, design and actual
i. Entering water temperature, design and actual
j. Leaving water temperature, design and actual
k. Entering air temperature, design and actual
l. Leaving air temperature, design and actual

17. Air Moving Equipment:

a. Location
b. Manufacturer
c. Model number
d. Serial number
e. Arrangement/Class/Discharge
f. Air flow, specified and actual
g. Return air flow, specified and actual
h. Outside air flow, specified and actual
i. Total static pressure (total external), specified and actual
j. Inlet pressure
k. Discharge pressure
l. Sheave Make/Size/Bore

m. Number of Belts/Make/Size
n. Fan RPM

18. Return Air/Outside Air Data:

    a. Identification/location
    b. Design air flow
    c. Actual air flow
    d. Design return air flow
    e. Actual return air flow
    f. Design outside air flow
    g. Actual outside air flow
    h. Return air temperature
    i. Outside air temperature
    j. Required mixed air temperature
    k. Actual mixed air temperature
    l. Design outside/return air ratio
    m. Actual outside/return air ratio

19. Exhaust Fan Data:

    a. Location
    b. Manufacturer
    c. Model number
    d. Serial number
    e. Air flow, specified and actual
    f. Total static pressure (total external), specified and actual
    g. Inlet pressure
    h. Discharge pressure
    i. Sheave Make/Size/Bore
    j. Number of Belts/Make/Size
    k. Fan RPM

20. Duct Traverse:

    a. System zone/branch
    b. Duct size
    c. Area
    d. Design velocity
    e. Design air flow
    f. Test velocity
    g. Test air flow
    h. Duct static pressure
    i. Air temperature
    j. Air correction factor

21. Duct Leak Test:

    a. Description of ductwork under test
    b. Duct design operating pressure
    c. Duct design test static pressure

d. Duct capacity, air flow
e. Maximum allowable leakage duct capacity times leak factor
f. Test apparatus
    (1) Blower
    (2) Orifice, tube size
    (3) Orifice size
    (4) Calibrated

g. Test static pressure
h. Test orifice differential pressure
i. Leakage

22. Air Monitoring Station Data:

    a. Identification/location
    b. System
    c. Size
    d. Area
    e. Design velocity
    f. Design air flow
    g. Test velocity
    h. Test air flow

23. Flow Measuring Station:

    a. Identification/number
    b. Location
    c. Size
    d. Manufacturer
    e. Model number
    f. Serial number
    g. Design Flow rate
    h. Design pressure drop
    i. Actual/final pressure drop
    j. Actual/final flow rate
    k. Station calibrated setting

24. Terminal Unit Data:

    a. Manufacturer
    b. Type, constant, variable, single, dual duct
    c. Identification/number
    d. Location
    e. Model number
    f. Size
    g. Minimum static pressure
    h. Minimum design air flow
    i. Maximum design air flow
    j. Maximum actual air flow
    k. Inlet static pressure

25. Air Distribution Test Sheet:

a. Air terminal number
b. Room number/location
c. Terminal type
d. Terminal size
e. Area factor
f. Design velocity
g. Design air flow
h. Test (final) velocity
i. Test (final) air flow
j. Percent of design air flow

26. Sound Level Report:

a. Location
b. Octave bands - equipment off
c. Octave bands - equipment on
d. RC level - equipment on

27. Vibration Test:

a. Location of points:

1) Fan bearing, drive end
2) Fan bearing, opposite end
3) Motor bearing, center (when applicable)
4) Motor bearing, drive end
5) Motor bearing, opposite end
6) Casing (bottom or top)
7) Casing (side)
8) Duct after flexible connection (discharge)
9) Duct after flexible connection (suction)

a. Test readings:

1) Horizontal, velocity and displacement
2) Vertical, velocity and displacement
3) Axial, velocity and displacement

a. Normally acceptable readings, velocity and acceleration

b. Unusual conditions at time of test
c. Vibration source (when non-complying)

C. System diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Balancing stations.
4. Position of balancing devices.

3.11 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

    a. Measure airflow of at least 10 percent of air outlets.
    b. Measure water flow of at least 5 percent of terminals.
    c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
    d. Verify that balancing devices are marked with final balance position.
    e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Owner.
3. Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, CAWCD may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.12 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions. Coordinate the additional test with CAWCD 14 days prior to desired test date.

B. 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 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. HVAC piping insulation, jackets, and accessories.
2. HVAC equipment insulation, jackets, and accessories.
3. HVAC ductwork insulation, jackets, and accessories.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit product description, thermal characteristics, list of materials, thickness for each service, and location.
2. Submit manufacturers published literature indicating proper installation procedures.

B. Shop Drawings (SD)

1. Include plans, elevations, sections, details, and attachments to other work.
2. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
3. Detail insulation application at elbows, fittings, dampers, specialties, and flanges for each type of insulation.
4. Detail application of field applied jackets.
5. Detail application at linkages of control devices.

C. Samples (S)

1. Submit two samples of representative size illustrating each insulation type.

1.3 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

1. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.

2. Surface burning characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency approved by CAWCD. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

    a. Insulation installed indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
    b. Insulation installed outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 QUALIFICATIONS

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

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

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

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Manufacturers; Glass Fiber and Mineral Fiber Insulation:

1. Johns Manville; a Berkshire Hathaway company
2. Owens Corning

3. Manson Insulation Inc.

B. Manufacturers; Closed Cell Elastomeric Insulation:

1. Aeroflex USA
2. Armacell LLC
3. K-Flex USA

C. Manufacturers; Polyisocyanurate Foam Insulation:

1. Johns Manville; a Berkshire Hathaway company

D. Manufacturers; Extruded Polystyrene Insulation:

1. Dow Chemical Co., sold through Polyguard Products, Inc.
2. Johns Manville; a Berkshire Hathaway company

E. Manufacturers; Fire-Rated Blanket

1. Thermal Ceramics

2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE P-2: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.

C. TYPE P-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: 0 to 650 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

D. TYPE P-4: ASTM C612; semi-rigid, fibrous glass board noncombustible. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: 0 to 650 degrees F.

E. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

F. TYPE P-6: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.30 at 75 degrees F.
2. Maximum Service Temperature: 300 degrees F.
3. Operating Temperature Range: Range: Minus 58 to 300 degrees F.

G. TYPE P-7: ASTM C534, Type I, flexible, non-halogen, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Maximum Service Temperature: 250 degrees F.
3. Operating Temperature Range: Range: Minus 58 to 250 degrees F.

H. TYPE P-8: ASTM C547, Type I or II, mineral fiber preformed pipe insulation, noncombustible.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Maximum Service Temperature: 1200 degrees F.
3. Canvas Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric treated with fire retardant lagging adhesive.

I. TYPE P-9: ASTM C591, Type IV, polyisocyanurate foam insulation, formed into shapes for use as pipe insulation.

1. Density: 4.0 pounds per cubic foot.
2. Thermal Conductivity: 180-day aged value of 0.19 at 75 degrees F.
3. Operating Temperature Range: Range: Minus 297 to 300 degrees F.
4. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of 6 mils thickness and water vapor permeance of 0.01 perms.

J. TYPE P-10: ASTM C578, Type XIII, extruded polystyrene insulation, formed into shapes for use as pipe insulation.

1. Thermal Conductivity: 180-day aged value of 0.259 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 297 to 165 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of 6 mils thickness and water vapor permeance of 0.01 perms.

K. TYPE P-11: ASTM C533; Type I, hydrous calcium silicate pipe insulation, rigid molded white; asbestos free.

1. Thermal Conductivity: 0.45 at 200 degrees F.
2. Operating Temperature Range: 140 to 1200 degrees F.

2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:

1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

B. PVC Plastic Pipe Jacket:

1. Product Description: ASTM D1785, one piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 30 mil.
3. Connections: Pressure sensitive color matching vinyl tape and vapor retarder mastic.

C. ABS Plastic Pipe Jacket:

1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
2. Minimum service temperature: -40 degrees F.
3. Maximum service temperature of 180 degrees F.
4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
5. Thickness: 30 mil.
6. Connections: Brush on welding adhesive.

D. Aluminum Pipe Jacket:

1. ASTM B209.
2. Thickness: 0.016-inch-thick sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2-inch laps.
5. Fittings: 0.016-inch-thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 1/2 inch wide; 0.020-inch-thick stainless steel.

E. Stainless Steel Pipe Jacket:

1. ASTM A240/A240M OR ASTM 666 Type 304 or 316 stainless steel.
2. Thickness: 0.018inch thick.
3. Finish: Smooth.
4. Metal Jacket Bands: 1/2 inch wide; 0.020-inch-thick stainless steel.

F. Field Applied Glass Fiber Fabric Jacket System:

1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:

    a. Cloth: Untreated; 9 oz/sq yd weight.
    b. Blanket: 1.0 lb/cu ft density.

3. Indoor Vapor Retarder Finish:

    a. Cloth: Untreated; 9 oz/sq yd weight.
    b. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with stainless steel jacket single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048-inch stainless steel with twisted ends on maximum 12 inch centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: 1.65 pound per cubic foot.

B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied reinforced aluminum foil jacket.

1. Thermal Conductivity: 0.24 at 75 degrees F.
2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: 3.0 pound per cubic foot.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

C. TYPE E-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: 0 to 650 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

D. TYPE E-4: ASTM C612; semi-rigid, fibrous glass board noncombustible.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: 0 to 650 degrees F.

E. TYPE E-5: ASTM C612; glass fiber, semi-rigid board, noncombustible.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Maximum Operating Temperature: 850 degrees F.
3. Density: 3.0 pound per cubic foot.

F. TYPE E-6: ASTM C553; mineral fiber blanket, Type I.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Maximum Operating Temperature: 1000 degrees F.
3. Density: 1.0 pound per cubic foot.

G. TYPE E-7: ASTM C533; Type II, hydrous calcium silicate block insulation, asbestos free.

1. Thermal Conductivity: 0.45 at 200 degrees F.
2. Operating Temperature Range: 140 to 1200 degrees F.

H. TYPE E-8: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.

I. TYPE E-9: ASTM C612, man-made mineral fiber, noncombustible, Classes 1-4.

1. Thermal Conductivity: 0.25 at 100 degrees F.
2. Maximum Service Temperature: 1200 degrees F.
3. Density: 8 pound per cubic foot.

2.6 EQUIPMENT INSULATION JACKETS

A. PVC Plastic Equipment Jacket:

1. Product Description: ASTM D1785, sheet material, off-white color.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 150 degrees F.
4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
5. Thickness: 20 mil.
6. Connections: Pressure sensitive color matching vinyl tape.

B. Aluminum Equipment Jacket:

1. ASTM B209Thickness: 0.032-inch-thick sheet.
2. Finish: Embossed.
3. Joining: Longitudinal slip joints and 2-inch laps.
4. Fittings: 0.016-inch-thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.010-inch-thick stainless steel.

C. Stainless Steel Equipment Jacket:

1. ASTM A240/A240M OR ASTM 666 Type 304 or 316 stainless steel.
2. Thickness: 0.018inch thick.
3. Finish: Corrugated.
4. Metal Jacket Bands: 3/8 inch wide; 0.010inch thick stainless steel.

D. Canvas Equipment Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

E. Vapor Retarder Jacket:

1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

F. Field Applied Glass Fiber Fabric Jacket System:

1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:

a. Cloth: Untreated; 9 oz/sq yd weight.
b. Blanket: 1.0 lb/cu ft density.
c. Weave: [5 x 5] [10 x 10] [10 x 20].

3. Indoor Vapor Retarder Finish:

a. Cloth: Untreated; 9 oz/sq yd weight.
b. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.7 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Tie Wire: 0.048-inch stainless steel with twisted ends on maximum 12-inch centers.

D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

E. Adhesives: Compatible with insulation.

2.8 DUCTWORK INSULATION

A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.

1. Thermal Conductivity: 0.25 at 75 degrees F.
2. Maximum Operating Temperature: 250 degrees F.
3. Density: 1.5 pound per cubic foot.

B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied reinforced aluminum foil facing meeting ASTM C1136, Type II.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Density: 2.25 pound per cubic foot.

C. TYPE D-3: ASTM C612, Type IA or IB, rigid glass fiber, no facing.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Density: 2.25 pound per cubic foot.

D. TYPE D-4: ASTM C1071, Type I, flexible, glass fiber duct liner with coated air side.

1. Thermal Conductivity: 0.24 at 75 degrees F.
2. Density: 2.0 pound per cubic foot.
3. Maximum Operating Temperature: 250 degrees F.
4. Maximum Air Velocity: 6,000 feet per minute.

E. TYPE D-5: ASTM C1071, Type II, rigid, glass fiber duct liner with coated air side.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Density: 3.0 pound per cubic foot.
3. Maximum Operating Temperature: 250 degrees F.
4. Maximum Air Velocity: 4,000 feet per minute.

F. TYPE D-6: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Service Temperature Range: Range: Minus 58 to 180 degrees F.

G. TYPE D-7: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet laminated with white thermoplastic rubber membrane.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Service Temperature Range: Range: Minus 58 to 180 degrees F.

H. TYPE D-8: ASTM E2336, fire-rated, inorganic blanket encapsulated with scrim reinforced foil meeting UL 1978.

1. Thermal Conductivity: 0.42 at 500 degrees F.
2. Maximum Weight: 1.4 pound per square foot.
3. Surface Burning Characteristics: Maximum 0/0 flame spread/smoke developed index when tested in accordance with ASTM E84.

2.9 DUCTWORK INSULATION JACKETS

A. Aluminum Duct Jacket:

1. ASTM B209.
2. Thickness: 0.032-inch-thick sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2-inch laps.

5. Fittings: 0.016-inch-thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.010-inch-thick stainless steel.

B. Vapor Retarder Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film 0.0032-inch vinyl.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
3. Secure with pressure sensitive tape.

C. Canvas Duct Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

D. Membrane Duct Jacket: ASTM D4637; Type I, EPDM; non-reinforced, 0.060 inch thick, 48-inch-wide roll; white color as selected.

2.10 DUCTWORK INSULATION ACCESSORIES

A. Vapor Retarder Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber-based adhesive.

B. Vapor Retarder Lap Adhesive: Compatible with insulation.

C. Adhesive: Waterproof, ASTM E162 fire-retardant type.

D. Liner Fasteners: Galvanized steel, welded with integral head.

E. Tie Wire: 0.048-inch stainless steel with twisted ends on maximum 12-inch centers.

F. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

H. Adhesives: Compatible with insulation.

I. Membrane Adhesives: As recommended by membrane manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify piping, equipment, and ductwork has been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 078400 for penetrations of assemblies with fire resistance rating greater than one hour.

C. Piping Systems Conveying Fluids Below Ambient Temperature:

1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:

1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Polyisocyanurate Foam Insulation and Extruded Polystyrene Insulation:

1. Wrap elbows and fitting with vapor retarder tape.
2. Seal butt joints with vapor retarder tape.

F. Hot Piping Systems less than 140 degrees F:

1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

G. Hot Piping Systems greater than 140 degrees F:

1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

H. Inserts and Shields:

1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.

    a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
    b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.

3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

I. Insulation Terminating Points:

1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
3. Condensate Piping: Insulate entire piping system and components to prevent condensation.

J. Closed Cell Elastomeric Insulation:

1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer’s recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

K. High Temperature Pipe Insulation:

1. Cover with stainless steel jacket with seams located on bottom side of horizontal piping.

L. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.

M. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o’clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

N. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

O. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.

P. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

Q. Prepare pipe insulation for finish painting. Refer to Section 099000.

3.3 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:

1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees F Or Less:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment Containing Fluids Over 140 degrees F:

1. Insulate flanges and unions with removable sections and jackets.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

G. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.

H. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

I. Cover glass fiber type insulation with aluminum or stainless steel jacket.

J. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

K. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

L. Prepare equipment insulation for finish painting. Refer to Section 099000.

3.4 INSTALLATION - DUCTWORK SYSTEMS

A. Duct dimensions indicated on Drawings are finished inside dimensions.

B. Insulated ductwork conveying air below ambient temperature:

1. Provide insulation with vapor retarder jackets.
2. Finish with tape and vapor retarder jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ductwork conveying air above ambient temperature:

1. Provide with or without standard vapor retarder jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces:

1. Finish with aluminum jacket.

E. External Glass Fiber Duct Insulation:

1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
2. Secure insulation without vapor retarder with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

F. External Elastomeric Duct Insulation:

1. Adhere to clean oil-free surfaces with full coverage of adhesive.
2. Seal seams and butt joints with manufacturer's recommended adhesive.
3. When application requires multiple layers, apply with joints staggered.
4. Insulate standing metal duct seams with insulation of like material and thickness as adjacent duct surface. Apply adhesive at joints with flat duct surfaces.
5. Lift ductwork off trapeze hangers and insert spacers.

G. Duct Liner:

1. Adhere insulation with adhesive for 100 percent coverage.
2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
3. Seal and smooth joints. Seal and coat transverse joints.
4. Seal liner surface penetrations with adhesive.
5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.

H. Kitchen Exhaust Ductwork:

1. Comply with manufacturer's written installation instructions.
2. Cover duct by wrapping with insulation using overlap method.
3. Overlap seams of each method by 3 inches to maintain a continuous fire rating.
4. Attach insulation using steel banding or by welded pins and clips.
5. Install insulation without sag on underside of ductwork. Use additional fasteners to prevent sagging.
6. Install firestopping at penetrations through fire-rated assemblies per Section 078400.

I. Ducts Exterior to Building:

1. Install insulation according to external duct insulation paragraph above.
2. Provide external insulation with vapor retarder jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct.
3. Finish with aluminum duct jacket.
4. Calk seams at flanges and joints. Located major longitudinal seams on bottom side of horizontal duct sections.

J. Prepare duct insulation for finish painting. Refer to Section 099000.

END OF SECTION 230700

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. HVAC commissioning description.
2. HVAC commissioning responsibilities.

1.2 COMMISSIONING DESCRIPTION

A. HVAC commissioning process includes the following tasks:

1. Testing and startup of HVAC equipment and systems.
2. Equipment and system verification checks.
3. Assistance in functional performance testing to verify testing and balancing, and equipment and system performance.
4. Provide qualified personnel to assist in commissioning tests, including seasonal testing.
5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
7. Provide operation and maintenance information, list of PM tasks, recommended frequency, any instructions or diagrams needed to do the maintenance task, and record drawings to Commissioning Authority for review verification and organization, prior to distribution. Provide a detailed list of any spare parts, consumables, or special tools that may be needed for long-term maintenance.
8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
9. Provide training for systems specified in this Section with coordination by Commissioning Authority.

B. Equipment and Systems to Be Commissioned:

1. New HVAC systems that were installed under this Contract.
2. Existing HVAC systems that were modified, adjusted, upgraded, or affected by the work performed under this Contract.

C. The following is a partial list of equipment that may be included in this HVAC Commissioning:

1. Chillers.
2. Pumps.
3. Cooling tower.
4. Boilers.

5. Piping systems.
6. Ductwork.
7. Variable frequency drives.
8. Packaged roof top air conditioning units.
9. Split system air conditioning units.
10. Air handling units.
11. Hot water terminal heating equipment.
12. Constant volume terminal units.
13. Variable volume terminal units.
14. Fans.
15. Chemical treatment systems.
16. Fire dampers.
17. Smoke dampers.
18. Control valves.
19. Pressure regulating valves.
20. Circuit setting valves.
21. Equipment sound control.
22. Equipment vibration control.
23. Egress pressurization.
24. Automatic HVAC control system.
25. Testing, Adjusting and Balancing work.

D. Perform seasonal function performance tests for the following equipment and systems:

1. Heating equipment during heating season.
2. Cooling equipment during cooling season.

1.3 SUBMITTALS

A. Draft Forms: Submit draft of system verification form and functional performance test checklist tailored to the project specifics of this contract.

B. Certificate of Readiness: Signed by the contractor, certifying that the HVAC&R systems, assemblies, equipment, and associated controls are ready for testing.

C. Commissioning Reports:

1. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified. Use AABC forms as guidelines.
2. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.

D. Certificate of Completion: Certifying that the installation, prestart checklists, and startup procedures on all equipment in scope has been completed.

E. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning. Commissioning Agent is to work with contractors on the installation progress and is ultimately responsible for ensuring that the Contractor has accurately updated Record Documents to as built conditions. Commissioning Agent shall notify CAWCD in the event commissioning necessitates changes in the project record drawings.

F. Operation and Maintenance Data: Commissioning Agent to work with Contractor and TAB Contractor and provide final HVAC Commissioning package with the final O&M Documents submitted to CAWCD. Provide a list of any 'as left' setpoints and other similar metrics if they aren't already provided elsewhere or in the OEM manuals.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ACG, ASHRAE Guideline 1, NEBB, or TABB requirements. Forms to be approved by engineer.

1.5 QUALIFICATIONS

A. Commissioning Authority: A certified commissioning authority (CxA) by the AABC Commissioning Group (ACG) or approved by CAWCD.

1.6 COMMISSIONING RESPONSIBILITIES

A. General Contractor Commissioning Responsibilities

1. Retain services for an independent qualified 3rd party Commissioning Authority. CAWCD to provide approval of Commissioning Agency selected prior to GMP. CAWCD retains the right to hire the 3rd party Commissioning Authority.
2. Provide CAWCD a schedule of commissioning activities and meetings including (but not limited to) the items outlined in Article 1.9.
3. Delivery of plans, submittals, system manuals, and any other equipment-related information for the Commissioning Authority to review prior to field commissioning.

B. Equipment or System Installer Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Ensure temperature controls installer performs assigned commissioning responsibilities as specified below.
3. Ensure testing, adjusting, and balancing agency performs assigned commissioning responsibilities as specified.
4. Provide instructions and demonstrations for Owner's personnel.
5. Ensure subcontractors perform assigned commissioning responsibilities.
6. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
7. Develop startup and initial checkout plan using manufacturer's startup procedures and functional performance checklists for equipment and systems to be commissioned.
8. During verification check and startup process, execute HVAC related portions of checklists for equipment and systems to be commissioned.
9. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
10. Provide manufacturer's representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.

11. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
12. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
13. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
14. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
15. Provide factory supervised startup services for equipment and systems (Chillers pumps, boilers, cooling towers, air handling units). Coordinate work with manufacturer and Commissioning Authority.
16. Perform verification checks and startup on equipment and systems as specified. Provide report showing correlation between digital temperature and pressure readings at the same point on the piping system and thermostats.
17. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
18. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
19. Conduct HVAC system orientation and inspection.

C. Temperature Controls Installer Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Review design for ability of systems to be controlled including the following:

    a. Confirm proper hardware requirements exists to perform functional performance testing.
    b. Confirm proper safeties and interlocks are included in design.
    c. Confirm proper sizing of system control valves and actuators and control valve operation will result capacity control identified in Contract Documents.
    d. Confirm proper sizing of system control dampers and actuators and damper operation will result in proper damper positioning.
    e. Confirm sensors selected are within device ranges.
    f. Review sequences of operation and obtain clarification from CAWCD.
    g. Indicate delineation of control between packaged controls and building automation system, listing BAS monitor points and BAS adjustable control points.
    h. Provide written sequences of operation for packaged controlled equipment. Equipment manufacturers' stock sequences may be included, when accompanied by additional narrative to reflect Project conditions.

3. Inspect, check, and confirm proper operation and performance of control hardware and software provided in other HVAC sections.
4. Submit proposed procedures for performing automatic temperature control system point-to-point checks to Commissioning Authority and CAWCD.

5. Inspect check and confirm correct installation and operation of automatic temperature control system input and output device operation through point-to-point checks.
6. Perform training sessions to instruct CAWCD's personnel in hardware operation, software operation, programming, and application in accordance with commissioning plan and requirements of Section 230900 and 230923.
7. Demonstrate system performance and operation to Commissioning Authority during functional performance tests including each mode of operation.
8. Provide control system technician to assist during Commissioning Authority verification check and functional performance testing.
9. Provide control system technician to assist testing, adjusting, and balancing agency during performance of testing, adjusting, and balancing work.
10. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

D. Testing, Adjusting, and Balancing Agency Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Participate in verification of testing, adjusting, and balancing report for verification or diagnostic purposes. Repeat sample of 10 percent of measurements contained in testing, adjusting, and balancing report as indicated in commissioning plan.
3. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

1.7 COMMISSIONING MEETINGS

A. Coordinate all commissioning meetings and progress commissioning meetings with the General Contractor, HVAC Contractor, TAB Contractor, and CAWCD.

1.8 SCHEDULING

A. Commissioning Agent to attend pre-installation meetings prior to any HVAC work being performed. Contractor should have Commissioning Agent under contract prior to any HVAC installations.

B. Prepare schedule indicating anticipated start dates for the following:

1. Piping system pressure testing.
2. Piping system flushing and cleaning.
3. Ductwork cleaning.
4. Ductwork pressure testing.
5. Equipment and system startups.
6. Automatic temperature control system checkout.
7. Testing, adjusting, and balancing.
8. HVAC system orientation and inspections.
9. Operation and maintenance manual submittals.
10. Training sessions. Provide two week notice of training sessions for CAWCD staff.

C. Schedule seasonal tests of equipment and systems during peak weather conditions to observe full-load performance.

D. Schedule occupancy sensitive tests of equipment and systems during conditions of both minimum and maximum occupancy or use.

1.9 COORDINATION

A. Notify CAWCD Project Engineer and Project Manager a minimum of four weeks in advance of the following:

1. Scheduled equipment and system startups.
2. Scheduled automatic temperature control system checkout.
3. Scheduled start of testing, adjusting, and balancing work.

B. Coordinate programming of automatic temperature control system with construction and commissioning schedules.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

B. Certify that HVAC instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and all systems are set to and maintaining set points as required by the design documents.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.2 INSTALLATION

A. Install additional balancing dampers, balancing valves, access doors, test ports, and pressure and temperature taps required to meet performance requirements.

B. Place HVAC systems and equipment into full operation and continue operation during each working day of commissioning.

C. Install replacement sheaves and belts to obtain system performance, as requested by Commissioning Authority.

D. Install test holes in ductwork and plenums as requested by Commissioning Authority for taking air measurements.

E. Prior to start of functional performance test, install replacement filters in equipment.

3.3 FIELD TESTS AND INSPECTIONS

A. Seasonal Sensitive Functional Performance Tests:

1. Test heating equipment at winter design temperatures.
2. Test cooling equipment at summer design temperatures with fully occupied building.
3. Participate in testing delayed beyond Final Completion to test performance at peak seasonal conditions.

B. Be responsible to participate in initial and alternate peak season test of systems required to demonstrate performance.

C. Occupancy Sensitive Functional Performance Tests:

1. Test equipment and systems affected by occupancy variations at minimum and peak loads to observe system performance.
2. Participate in testing delayed beyond Final Completion to test performance with actual occupancy conditions.

END OF SECTION 230800

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.2 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. MS/TP: Master slave/token passing.

D. PC: Personal computer.

E. PID: Proportional plus integral plus derivative.

F. RTD: Resistance temperature detector.

1.3 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphics with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy (Accuracy applies to 10% - 100% of scale) and Stability of Control: Report values and maintain measured variables within tolerances as follows:

    a. Water Temperature: Plus or minus 1 deg F (0.5 deg C).
    b. Water Flow: Plus or minus 2 percent of full scale.

c. Water Pressure: Plus or minus 2 percent of full scale for both absolute and differential pressure.
d. Space Temperature: Plus or minus -2 deg F (1.0 deg C).
e. Ducted Air Temperature: Plus or minus -3 deg F (1.5 deg C).
f. Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
g. Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
h. Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
i. Relative Humidity: Plus or minus 5 percent.
j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
l. Airflow (Terminal): Plus or minus 10 percent of full scale.
m. Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
n. Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
o. Carbon Monoxide: Plus or minus 5 percent of reading.
p. Carbon Dioxide: Plus or minus 50 ppm.
q. Electrical (A, V, W, Power Factor): Plus or minus -1 percent of reading.
r. Fluid Pressure: Plus or minus 1.5 PSI (10 kPa), Range of medium MPa (1-150 PSI)
s. Fluid Pressure: Plus or minus 1.0-inch wg (250 Pa), Differential 0-50-inch wg (0-12.5 kPa)

1.4 SEQUENCE OF OPERATION

A. Refer to Section 230993 – Sequence of Operations for HVAC Controls

1.5 ACTION SUBMITTALS

A. Product Data (PD):

1. Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

B. DDC System Hardware:

1. Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

C. Control System Software:

1. Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

D. Controlled Systems:

1. Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

E. Shop Drawings:

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. Bill of materials of equipment indicating quantity, manufacturer, and model number.
3. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
4. Wiring Diagrams: Power, signal, and control wiring.
5. Details of control panel faces, including controls, instruments, and labeling.
6. Written description of sequence of operation.
7. Schedule of dampers including size, leakage, and flow characteristics.
8. Schedule of valves including flow characteristics.

F. DDC System Hardware:

1. Wiring diagrams for control units with termination numbers.
2. Schematic diagrams and floor plans for field sensors and control hardware.
3. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

G. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.

H. Controlled Systems:

1. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
2. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
3. Written description of sequence of operation including schematic diagram.
4. Points list.

1.6 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

B. Qualification Data: For Installer and manufacturer.

C. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

D. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

B. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.

C. Interconnection wiring diagrams with identified and numbered system components and devices.

D. Keyboard illustrations and step-by-step procedures indexed for each operator function.

E. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

F. Calibration records and list of set points.

G. Software and Firmware Operational Documentation: Include the following:

H. Software operating and upgrade manuals.

I. Program Software Backup: On a magnetic media or compact disc, complete with data files.

J. Device address list.

K. Printout of software application and graphic screens.

L. Software license required by and installed for DDC workstations and control systems.

1.8 GENERAL SUBMITTALS (G)

A. Project Record Documents: Submit three copies of record (as-built) documents upon completion of installation for approval by CAWCD prior to final completion. Submittal shall consist of:

1. Project Record Drawings. As-built versions of submittal shop drawings provided in latest AutoCAD format.
2. Operation and Maintenance (O&M) Manual.

    a. As-built versions of submittal product data.
    b. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
    c. Operator’s manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
    d. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.

e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
f. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.
g. Graphic files, programs, and database on magnetic or optical media.
h. List of recommended spare parts with part numbers and suppliers.
i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
j. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
k. Licenses, guarantees, and warranty documents for equipment and systems.
l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

3. Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions at CAWCD's headquarters site. CAWCD will modify course outlines and materials if necessary to meet CAWCD's needs. Contracting Officer will review and approve course outlines and materials at least three weeks before first class.

B. Quality Control Reports (QCR):

1. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 230800.

1.9 WARRANTY

A. Warrant work as follows:

1. Warrant labor and materials for specified control system free from defects for a period of 24 months after substantial completion. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to CAWCD. Respond within 24 hours of Contracting Officer's warranty service request.
2. Work shall have a warranty date per site after substantial completion, even if CAWCD receives beneficial use due to early system start-up.
3. If the Contracting Officer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Contracting Officer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
4. Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If

available, CAWCD can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Contracting Officer's written authorization.

5. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

1.10 OWNERSHIP OF PROPRIETARY MATERIAL

A. Project-specific software and documentation shall become CAWCD's property. This includes, but is not limited to:

1. Graphics
2. Record drawings
3. Database
4. Application program code
5. Documentation

1.11 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.13 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

C. Coordinate equipment with Section 260913 to achieve compatibility of communication interfaces.

D. Coordinate equipment with Section 262416 to achieve compatibility with starter coils and annunciation devices.

E. Coordinate equipment with Section 262419 to achieve compatibility with motor starters and annunciation devices.

F. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

A. Manufacturers: Automated Logic Corporation. No substitutes or equals allowed.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.2 DDC EQUIPMENT

A. Touch Screen HMI Interface Workstation with full graphical interface to the system.

1. ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

B. Manufacturer

1. Intel or approved equal

C. Minimum Configuration

1. Mounting – Flush Panel Mounted, Aluminum powder coated housing.
2. Processor – IntelR Core Duo 2.33Ghz
3. Hard Drive – 80GB
4. Memory – 4GB
5. Display – 19” minimum, high resolution 1280x1024, VGA
6. Communication – Ethernet Lan 10/100, 4USB ports.
7. Operator workstation operating system: Current Windows operating system as approved by CAWCD.
8. Application Software:

a. I/O capability from operator station.
b. System security for each operator via software password and access levels.
c. Automatic system diagnostics; monitor system and report failures.

d. Database creation and support.
e. Automatic and manual database save and restore.
f. Dynamic color graphic displays.
g. Custom graphics generation and graphics library of HVAC equipment and symbols.
h. Alarm processing, messages, and reactions.
i. Trend logs retrievable in spreadsheets and database programs.
j. Alarm and event processing.
k. Object and property status and control.
l. Automatic restart of field equipment on restoration of power.
m. Data collection, reports, and logs. Include standard reports for the following:

1) Current values of all objects.
2) Current alarm summary.
3) Disabled objects.
4) Alarm lockout objects.
5) Logs.

n. Custom report development.
o. Utility and weather reports.
p. Workstation application editors for controllers and schedules.
q. Maintenance management.

9. Custom Application Software:

a. English language oriented.
b. Full-screen character editor/programming environment.
c. Allow development of independently executing program modules with debugging/simulation capability.
d. Support conditional statements.
e. Support floating-point arithmetic with mathematic functions.
f. Contains predefined time variables.

D. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.
d. Software applications, scheduling, and alarm processing.
e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

    a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
    b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
    c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
    d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
    e. Remote communications.
    f. Maintenance management.
    g. Units of Measure: Inch-pound and SI (metric).

4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

E. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.

3. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

F. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/O's: Provide software selectable binary or analog outputs.

G. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

H. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.3 NETWORK AND DEVICE NAMING CONVENTION

A. Network Numbers shall be as indicated below or as otherwise approved by the Contracting Officer.

B. Network numbers shall be based on a "facility code, network" concept. The "facility code" is the CAWCD's assigned numeric value assigned to a specific facility or building. The "network" typically corresponds to a "floor" or other logical configuration within the building.

C. The network numbers are thus formed as follows: "Net #" = "FFFNN" where:

1. FFF= Facility code (see below)
2. NN = 00-99 This allows up to 100 networks per facility or building

D. Device Instances

1. Using unique device instances are formed as follows: "Dev #" = "FFFNNDD" where:

   a. FFF and N are as above and
   b. DD= 00-99, this allows up to 100 devices per network.

2. Note Special cases, where the network architecture of limiting device numbering to DD causes excessive subnetworks. The device number can be expanded to DDD and the network number N can become a single digit. In no case shall the network number N and the device number D exceed 4 digits.
3. Facility code assignments: Coordinate with CAWCD Representative.

E. Device Names

1. Provide device description and tag number as indicated on the contract drawings. Coordinate all naming conventions with CAWCD prior to software generation.

2.4 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform automatic system diagnostics, monitor system and report failures.
3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
4. Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).
5. Enclosure: Waterproof rated for operation at 40 to 150 deg F (5 to 65 deg C).
6. Enclosed controllers to be in conformance with Section 262913 “Enclosed Controllers”.

2.5 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 18 inches (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
4. Averaging Elements in Ducts: 72 inches (1830 mm) long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Exposed.
    b. Set-Point Indication: Exposed.

7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. RTDs and Transmitters:

1. Accuracy: Plus or minus 0.2 percent at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 18 inches (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
4. Averaging Elements in Ducts: 24 feet (7.3 m) long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Exposed.
    b. Set-Point Indication: Exposed.

7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. Humidity Sensors: Bulk polymer sensor element.

1. Accuracy: 5 percent full range with linear output.
2. Room Sensor Range: 20 to 80 percent relative humidity.
3. Room Sensor Cover Construction: Manufacturer's standard locking covers.
4. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
5. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F (minus 30 to plus 85 deg C)
6. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

    a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
    b. Output: 4 to 20 mA.
    c. Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
    d. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).

2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA.

4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

F. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
3. Adjusting Key: As required for calibration and cover screws.

2.6 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0 to 5-inch wg (0 to 1240 Pa).

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100 to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4 to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2 to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.7 GAS DETECTION EQUIPMENT

A. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F (0 to 40 deg C); with 2 factory-calibrated alarm levels at 35 and 200 ppm.

B. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55

deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4 to 20-mA output; for wall mounting.

C. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F (0 to 593 deg C) and calibrated for 0 to 5 percent, with continuous or averaged reading, 4 to 20-mA output; for wall mounting.

D. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

2.8 FLOW MEASURING STATIONS

A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.

1. Casing: Galvanized-steel frame.
2. Flow Straightener: Aluminum honeycomb, 3/4-inch (20-mm) parallel cell, 3 inches (75 mm) deep.
3. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

2.9 THERMOSTATS

A. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on every day of week.
7. Selection features include degree F or degree C display, 12 or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:

    a. Time of day.
    b. Actual room temperature.
    c. Programmed temperature.
    d. Programmed time.
    e. Duration of timed override.
    f. Day of week.
    g. System mode indications include "heating," "off," "fan auto," and "fan on."

B. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

C. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet (6 m).
2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

D. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or above set point.

1. Bulb Length: Minimum 20 feet (6 m).
2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

E. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig (172 kPa) and cast housing with position indicator and adjusting knob.

2.10 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).

6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:

a. Belimo Aircontrols (USA), Inc., No substitutes or equals allowed.

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:

a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
e. Dampers with 2 to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
f. Dampers with 3 to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 24 Vac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal 2 to 10-V dc or 4 to 20 mA, and 2 to 10-V dc position feedback signal.
10. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).

2.11 CONTROL VALVES

A. Manufacturers:

1. Belimo Aircontrols (USA), Inc.
2. Bray Controls

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 (DN 50) and Smaller: Class 250 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with back-seating capacity repackable under pressure.
2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

    a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 5-psig (35-kPa) maximum pressure drop at design flow rate or the following:

    a. Two Position: Line size.
    b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
    c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Butterfly Valves: 200-psig (1380-kPa), 150-psig (1034-kPa) maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

1. Body Style: Lug.
2. Disc Type: Nickel-plated ductile iron or Aluminum bronze
3. Sizing: 1-psig (7-kPa) maximum pressure drop at design flow rate.

E. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
2. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

F. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation.

B. Verify that duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

D. Install guards on thermostats in the following locations:

1. Entrances.
2. Public areas.
3. Where indicated.

E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

F. Install labels and nameplates to identify control components according to Section 230553.

G. Install hydronic instrument wells, valves, and other accessories according to Section 232116.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Section 260533.

B. Install building wire and cable according to Section 260519.

C. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

D. Connect hand-off auto selector switches to override automatic interlock controls when switch is in hand position.

E. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.

F. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.

G. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.

H. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

I. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

J. EMCS cabling shall be identified with printable cable labeling. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers. Handwritten labels are not acceptable. Use labeling systems manufactured by Brady Corporation or approved equal.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect**,** test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Pressure test control air piping at 30 psig (207 kPa) or 1.5 times the operating pressure for 24 hours, with maximum 5-psig (35-kPa) loss.
5. Pressure test high-pressure control air piping at 150 psig (1034 kPa) and low-pressure control air piping at 30 psig (207 kPa) for 2 hours, with maximum 1-psig (7-kPa) loss.
6. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
7. Test each point through its full operating range to verify that safety and operating control set points are as required.
8. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
9. Test each system for compliance with sequence of operation.
10. Test software and hardware interlocks.

3.5 CONTROL SYSTEM CHECKOUT AND TESTING

A. Startup Testing. Complete startup testing to verify operational control system before notifying The Contracting Officer of system demonstration. Provide The Contracting Officer with schedule for startup testing. The Contracting Officer may have representative present during any or all startup testing.

1. Calibrate and prepare for service each instrument, control, and accessory equipment furnished under this section.

2. Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.

3. Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.

4. Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.

5. Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.

6. Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated.

7. Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.

8. Alarms and Interlocks.

    a. Check each alarm with an appropriate signal at a value that will trip the alarm.

    b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.

    c. Test interlocks actions by simulating alarm conditions to check initiating value of variable and interlock action.

B. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size. Verify that inlet side is identified and that meters are installed correctly.

7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.6 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:

    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting systems to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.7 TRAINING

A. Provide training for the designated staff of CAWCD's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.

B. Training shall enable students to accomplish the following objectives.

1. Proficiently operate system
2. Understand control system architecture and configuration
3. Understand DDC system components
4. Understand system operation, including DDC system control and optimizing routines (algorithms)
5. Operate workstation and peripherals
6. Log on and off system
7. Access graphics, point reports, and logs
8. Adjust and change system setpoints, time schedules, and holiday schedules
9. Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
10. Understand system drawings and Operation and Maintenance manual
11. Understand job layout and location of control components
12. Access data from DDC controllers
13. Operate portable operator's terminals
14. Create and change system graphics
15. Create, delete, and modify alarms, including configuring alarm reactions
16. Create, delete, and modify point trend logs (graphs) and multi-point trend graphs
17. Configure and run reports
18. Add, remove, and modify system's physical points
19. Create, modify, and delete application programming

20. Add operator interface stations
21. Add a new controller to system
22. Download firmware and advanced applications programming to a controller
23. Configure and calibrate I/O points
24. Maintain software and prepare backups
25. Interface with job-specific, third-party operator software
26. Add new users and understand password security procedures

C. Divide presentation of objectives into three sessions (1-13, 14-23, and 24-26). Participants will attend one or more of the sessions, depending on knowledge level required.

1. Day-to-day Operators (objectives 1-13): 8 hours
2. Advanced Operators (objectives 1-13 and 14-23): Additional 8 hours, making 16 total hours
3. System Managers and Administrators (objectives 1-13 and 24-26): Additional 4 hours, making 12 total hours

D. Provide course outline and materials. Provide one copy of training material per student.

E. Instructors shall be factory-trained and experienced in presenting this material.

F. Perform classroom training using a network of working controllers representative of installed hardware.

3.8 DEMONSTRATION

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

END OF SECTION 230900

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes sequence of operation for the following systems:
   1. Air handling units
   2. Variable air volume terminal units with hot water reheat.
   3. General exhaust fans
   4. Chilled water plant control.
   5. Hot water plant control.
   6. Central refrigeration systems.
   7. Central fan systems.
   8. Exhaust fans.
   9. Excess pressure controls.
   10. Fan coil units.
   11. Heating Coils.
   12. Humidifiers.
   13. Refrigeration systems.
   14. Air terminal units.
   15. Electric Unit heaters.

1.2 ACTION SUBMITTALS

A. Shop Drawings (SD)

   1. Indicate mechanical system controlled and control system components.
   2. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
   3. Submit flow diagrams for each control system, graphically depicting control logic.
   4. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
   5. Coordinate submittals with information requested in Section 230900.

B. General (G)

   1. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 General

A. Programming

1. The DDC system shall be programmed according to the following sequence of operations including all energy reduction operations described in this sequence and in the project specifications.

B. System Status Display

1. The DDC system shall provide operating status for all systems controlled by the DDC system.
2. The displays shall include all points indicated on the drawings and any others required to achieve the sequence of operations.
3. The DDC system shall be able to integrate system diagnostics into control action decisions. This shall also include the ability to designate individual units as being in maintenance mode to avoid generating alarms.
4. All system control and status events shall be recorded, at the operator's selection, in the DDC system event log to facilitate troubleshooting.
5. All detected alarms or failures shall initiate an alarm within the DDC system.

C. Power Failure Recovery

1. The DDC system shall contain a power failure recovery mode (operator adjustable).
2. The power failure recovery capability shall return the system to its last state (before the building lost power).
3. Refer to power system recovery sequence for more details.

D. Occupancy Control

1. The DDC system shall be setup with an occupancy schedule for different areas of the building.
2. The owner shall be interviewed by the contractor at start-up to establish these schedules.
3. Some areas of the building shall be setup to be continuously occupied.

E. Emergency Outdoor Air Override

1. The DDC system shall have an emergency outdoor air override switch on the main graphic at the operator workstation which will allow the operator to shut down the outside air intake dampers and relief dampers for all air handling units in the event that toxic odors are detected outside.
2. When the outside air and relief dampers fully close, the return air damper shall fully open.
3. The outside air intake dampers for all units shall remain closed until the operator resets the override.

F. Start/Stop Optimization and Morning Warm-Up

1. The DDC system shall be programmed with a self-adjusting start/stop optimization sequence which shall provide the optimum start time for the unit in order to have the space temperature at the occupied setpoint when scheduled occupancy is to occur each day.

2. If the spaces require heating to reach the occupied space temperature setpoints, the DDC system shall operate the unit using a morning warm-up cycle. During the morning warm-up cycle, the unit shall operate with the outside air and relief air damper closed with the return air damper fully open.
3. The DDC system shall raise supply air temperature setpoint to the heating maximum temperature and operate the hot valve to maintain the supply air temperature at setpoint. Once the space temperature occupied setpoints are reached, the unit shall return to normal occupied control.
4. During morning warm-up, the terminal units shall operate at their maximum airflow setpoints until their space temperature setpoints are reached. Terminal units which do not require heating or have reached their occupied setpoints, shall operate with their dampers closed.

3.2 Air Handling Units

A. Supply Air Temperature Setpoint Control

1. The DDC system shall control the air handling unit to maintain an adjustable supply air temperature setpoint.
2. The temperature setpoint shall be reset from 55°F (adjustable) to 75°F (adjustable) based on the demand of the terminal units served by it so that at least one terminal unit is in full cooling (max airflow setpoint) and still maintaining the room temperature setpoint.

B. Supply Air Static Setpoint Control

1. The DDC system shall reset the static pressure setpoint using a trim and respond logic within the range of 0.5” w.g. to 1.5” w.g. When the fan is off, the setpoint shall be 1.0” w.g.
2. Once the fan is started, the setpoint shall be trimmed by 0.04” w.g. every two minutes if there are two or fewer zone pressure requests. If there are more than two zone pressure requests, respond by increasing the setpoint by 0.06” w.g.
3. A zone pressure request is generated when a VAV damper is greater than 95% open until it drops to 80% open. All setpoints shall be adjustable through the operator workstation.

C. Minimum Outside Air Setpoint Control

1. The DDC system shall monitor the CO2 level in the spaces throughout the building in locations indicated on the mechanical floor plans.
2. The time-based average for each CO2 sensor shall be calculated in an interval of 20 minutes (adjustable). The calculated value shall be used for control. In the event any of the CO2 levels rise above setpoint in accordance with ASHRAE 62.1 guidelines, the DDC system shall first gradually increase the flowrate of the terminal unit to induce additional outside air into the space.
3. If the terminal unit reaches its maximum airflow setpoint and the CO2 level is still not below setpoint, the DDC system shall reset the minimum outside air volume setpoint for the associated unit to induce more outside air into the air handling unit.
4. The minimum outside air volume setpoint shall be reset between the scheduled minimum and maximum setpoints. The DDC system shall initiate an alarm if the concentration levels rise 20% (adjustable) above setpoint.

5. The DDC system shall trend all carbon dioxide levels measured.

D. Mixed Air Damper Interlocks

1. Control signals from the DDC system shall modulate the mixed air dampers. Upon initial start-up, the DDC system will not begin modulation of the mixing dampers for five minutes (adjustable) to allow the control loops to stabilize.

E. Mixed Air Damper Control

1. The DDC system shall modulate the mixed air dampers to maintain the supply air temperature at set point. Whenever the outside air temperature is greater than the return air temperature and mechanical cooling is required, the mixed air dampers shall be in their normal position (full return air with minimum outside air).
2. When the air handling unit is stopped, the DDC system shall close all outside air dampers and the relief damper and open the return air damper.

F. Minimum Outside Air Control

1. The minimum outside air volume shall be controlled by the DDC system through the minimum outside air flow measuring damper which measures the minimum outside air volume. The DDC system shall not modulate the minimum outside air volume damper below minimum outside air volume setpoint.
2. If the air handling unit is stopped, the DDC system shall close the damper. If the minimum outside air damper is fully open with the economizer damper closed and the minimum outside air volume is below setpoint, the DDC system shall modulate the return air damper to maintain the minimum outside air volume at setpoint. The DDC system shall trend and log the outside air volume being brought in by the air handling unit.

G. Supply Air Temperature Control

1. The DDC system shall modulate the chilled water coil valve to maintain the supply air temperature setpoint.

H. Supply Fan Control

1. The supply fan VFD shall be started and stopped by the DDC system based on an occupancy schedule for the space programmed into the DDC system.
2. The fan shall operate continuously during occupied periods. If during unoccupied periods, any of the space temperatures rise above the unoccupied cooling setpoint or fall below the unoccupied heating setpoint, the air handling unit shall start and operate to change the space temperature 2°F (adjustable) before stopping.
3. If during unoccupied periods, any of the space occupancy switches are activated, the air handling unit shall start and operate for a period of two hours before stopping.

I. Supply Fan VFD Control

1. The VFD shall be modulated to maintain the supply duct static pressure at setpoint for the duct static pressure sensor which is farthest below setpoint. The ramp of

the VFD shall be adjusted to restrict the rate of change of the VFD output to sixty seconds for a zero to one hundred percent control signal change.

J. Supply Fan Monitoring

1. The VFD operation shall be indicated to the DDC system through a set of contacts in the VFD. If an alarm condition is detected, the DDC system shall initiate an alarm.

K. Return Fan VFD Control

1. The return fan shall operate whenever the supply fan operates. The DDC system shall measure the airflow volume of the return fan through airflow measuring station.
2. After the fan starts, the DDC system shall modulate the return fan to track the supply fan airflow using the following calculation.

    a. Return Air Volume = Supply Air Volume - Offset

3. The offset shall be the exhaust airflow for the associated space and the air required for building pressurization.
4. The offset shall be gradually reset by the DDC system based on the differential pressure measured in the space and the outside air pressure to maintain a positive space pressure of 0.05" w.c. (adjustable).
5. The ramp of the VFD shall be adjusted to restrict the rate of change of the VFD output to sixty seconds for a zero to one hundred percent control signal change.

L. Return Fan Monitoring

1. The VFD operation shall be indicated to the DDC system through a set of contacts in the VFD. If an alarm condition is detected, the DDC system shall initiate an alarm.

M. Filter Monitoring

1. The differential pressure across the filter shall be monitored by the DDC system through a differential pressure transmitter. If the differential pressure exceeds set point, the DDC system shall initiate an alarm.

N. Freezestat

1. A freezestat set at 35°F located in the mixed air plenum shall initiate an alarm at the DDC and stop the supply fans if an alarm condition is detected.

O. Smoke Detectors

1. Smoke detectors located in the supply air and return air streams, shall stop the fans through the fire alarm system if an alarm condition is detected. When the fans are stopped, the DDC system shall position the dampers to their normal state.

P. Duct Pressure Safety Switches

1. Safety switches installed in the supply and return air ducts for each unit shall alarm the DDC system if the duct pressure is above the high alarm setpoint.
2. The high alarm setpoint shall be 150% of the normal operating static of the system. If the DDC system senses an alarm condition, the DDC system shall stop the supply and return fans.

3.3 Variable Air Volume Terminal Units with Hot Water Reheat

A. Each terminal unit shall modulate the supply air damper to maintain the space temperature conditions. If the zone requires cooling, the supply air damper shall be modulated between the minimum and maximum cooling air flows to maintain the space temperature at the cooling setpoint of 76 °F (adjustable) for occupied periods and 85°F (adjustable) during unoccupied periods.

B. If the zone calls for heating, the supply air damper shall be modulated to a minimum and the heating valve shall be modulated open to maintain the space temperature at the heating setpoint of 72°F (adjustable) for occupied periods and 55°F for unoccupied periods.

C. If additional heating is required when the valve is fully open, the supply air damper shall be modulated to meet the room temperature requirements.

D. If during an unoccupied period the space occupancy switch is activated, the space shall return to the occupied setpoints for a period of two hours before switching back to the unoccupied state.

3.4 General Exhaust Fans

A. Exhaust Fan Control

1. Each fan shall operate based on the occupancy schedule in the DDC system. The fan shall operate continuously during occupied periods.

B. Exhaust Fan Monitoring

1. The fan operation shall be indicated to the DDC system through a current switch installed in the motor starter.
2. If a fan failure is detected, the DDC system shall stop the fan and initiate an alarm.

C. Exhaust Fan Isolation Damper Control

1. Each exhaust fan damper shall be open anytime the fan is operating. If the fan is stopped, the damper shall close.

3.5 Chilled Water Plant Control

A. Chiller - Run Conditions

1. The chiller will be enabled to run whenever:

a. A definable number of chilled water coils need cooling and the outside air temperature is greater than 54°F (adj.).
b. To prevent short cycling, the chiller will run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.
c. The chiller will run subject to its own internal safeties and controls.

B. Emergency Shutdown

1. The chiller will shut down and an alarm generated upon receiving an emergency shutdown signal status.

C. Chilled Water Pump

1. The VFD driven chilled water pump will run anytime the chiller is called to run. The chilled water pump will also run for freeze protection whenever the outside air temperature is less than a user definable setpoint (adj.).
2. The chilled water pump will start prior to the chiller being enabled and will stop only after the chiller is disabled. The chilled water pump will therefore have:

    a. A user adjustable delay on start and a user adjustable delay on stop.
    b. The delay times will be set appropriately to allow for orderly chilled water system start-up, shutdown, and sequencing.

3. Alarms will be provided as follows:

    a. Chilled Water Pump Failure: Commanded on, but the status is off.
    b. Chilled Water Pump Running in Hand: Commanded off, but the status is on.
    c. Chilled Water Pump Runtime Exceeded: Status runtime exceeds a user definable limit.

D. Chilled Water Differential Pressure Control

1. The controller will measure chilled water differential pressure and modulate the chilled water pump VFDs in sequence to maintain its chilled water differential pressure setpoint.
2. The following setpoints are recommended values. All setpoints will be field adjusted during the commissioning period to meet the requirements of actual field conditions.
3. The controller will modulate chilled water pump speeds to maintain a chilled water differential pressure of 12 psi (adj.). The VFDs minimum speed will not drop below 20% (adj.).
4. On dropping chilled water differential pressure, the VFDs will stage on and run to maintain setpoint as follows:

    a. The controller will modulate the lead VFD to maintain setpoint.
    b. If the lead VFD speed is greater than a setpoint of 90% (adj.), the lag VFD will stage on.
    c. The lag VFD will ramp up to match the lead VFD speed and then run in unison with the lead VFD to maintain setpoint.

5. On rising chilled water differential pressure, the VFDs will stage off as follows:

a. If the VFDs speeds then drops back to 60% (adj.) below setpoint, the lag VFD will stage off.
b. The lead VFD will continue to run to maintain setpoint.

6. Alarms will be provided as follows:

a. High Chilled Water Differential Pressure: If the chilled water differential pressure is 25% (adj.) greater than setpoint.
b. Low Chilled Water Differential Pressure: If the chilled water differential pressure is 25% (adj.) less than setpoint.

E. Chilled Water Bypass Valve - Loop Flow Control

1. The controller will measure chilled water loop flow and as the chilled water loop flow rises above setpoint, the controller will modulate the chilled water bypass valve open to maintain the loop flow setpoint.
2. Alarms will be provided as follows:

a. High Chilled Water Flow: If the chilled water flow is 25% (adj.) greater than setpoint.
b. Low Chilled Water Flow: If the chilled water flow is 25% (adj.) less than setpoint.

F. Condenser Water Pump

1. The condenser water pump will run anytime the chiller is called to run.
2. The condenser water pump will start prior to the chiller being enabled and will stop only after the chiller is disabled. The condenser water pump will therefore have:

a. A user adjustable delay on start.
b. A user adjustable delay on stop.

3. The delay times will be set appropriately to allow for orderly chilled water system start-up, shutdown, and sequencing.
4. The supply and return pressures will be monitored on each pump.
5. Alarms will be provided as follows:

a. Condenser Water Pump Failure: Commanded on, but the status is off.
b. Condenser Water Pump Running in Hand: Commanded off, but the status is on.
c. Condenser Water Pump Runtime Exceeded: Status runtime exceeds a user definable limit.
d. Condenser Water Pump High Supply Pressure: Pressure is greater than 35 psig (adj.).
e. Condenser Water Pump High Return Pressure: Pressure is greater than 35 psig (adj.).

G. Sand Filtration Pump

1. The sand filtration pump will run anytime the chiller is called to run.
2. The sand filtration pump will start prior to the chiller being enabled and will stop only after the chiller is disabled. The sand filtration pump will therefore have:

a. A user adjustable delay on start.
b. A user adjustable delay on stop.

3. The delay times will be set appropriately to allow for orderly system start-up, shutdown, and sequencing.
4. The supply and return pressures will be monitored on each pump.
5. Alarms will be provided as follows:

a. Sand Filtration Pump Failure: Commanded on, but the status is off.
b. Sand Filtration Pump Running in Hand: Commanded off, but the status is on.
c. Condenser Water Pump Runtime Exceeded: Status runtime exceeds a user definable limit.
d. Sand Filtration Pump High Supply Pressure: Pressure is greater than 35 psig (adj.).
e. Sand Filtration Pump High Return Pressure: Pressure is greater than 35 psig (adj.).

H. Chiller

1. The chiller will be enabled a user adjustable time after pump statuses are proven on and no chiller alarms are present. The chiller will therefore have a user adjustable delay on start.
2. The delay time will be set appropriately to allow for orderly chilled water system start-up, shutdown, and sequencing.
3. The chiller will run subject to its own internal safeties and controls.
4. Alarms will be provided as follows:

a. Chiller Failure: Commanded on, but the status is off.
b. Chiller Running in Hand: Commanded off, but the status is on.
c. Chiller Runtime Exceeded: Status runtime exceeds a user definable limit.
d. Chiller In Alarm: Chiller Alarm contact indicating alarm condition.

I. Chilled Water Supply Temperature - Setpoint

1. The DDC shall reset the chilled water supply temperature setpoint using a trim and respond algorithm based on cooling requirements.
2. The chilled water supply temperature setpoint will reset to a lower value as the facility's chilled water valves open beyond a user definable threshold (90% open, typ.). Once the chilled water coils are satisfied (valves closing) then the chilled water supply temperature setpoint will gradually rise over time to reduce cooling energy use.

J. Cooling Tower VFD Fan - Condenser Water Temperature Control

1. The controller will measure the cooling tower condenser water supply (basin) temperature and modulate the condenser water bypass valves and fan VFD in sequence to maintain setpoints.
2. The following setpoints are recommended values. All setpoints will be field adjusted during the commissioning period to meet the requirements of actual field conditions.

3. On rising supply temperature, the controller will modulate the condenser water bypass valves to maintain setpoint of 78°F (adj.) and the fan VFD to maintain setpoint of 82°F (adj.).
4. Alarms will be provided as follows:

    a. Cooling Tower Fan Failure: Commanded on, but the status is off.
    b. Cooling Tower Fan Running in Hand: Commanded off, but the status is on.
    c. Cooling Tower Fan Runtime Exceeded: Status runtime exceeds a user definable limit.
    d. High Cooling Tower Supply (Basin) Temp: If greater than 86°F (adj.).
    e. Low Cooling Tower Supply (Basin) Temp: If less than 38°F (adj.).

K. Chilled Water Temperature and pressure Monitoring

1. The following temperatures and pressures will be monitored:

    a. Chilled water supply temperature.
    b. Chilled water supply pressure.
    c. Chilled water return temperature.
    d. Chilled water return pressure.

L. Alarms will be provided as follows:

1. High Chilled Water Supply Temp: If the chilled water supply temperature is greater than 55°F (adj.).
2. Low Chilled Water Supply Temp: If the chilled water supply temperature is less than 38°F (adj.).
3. High Chilled Water Supply Press: If the chilled water supply pressure is greater than 35 psig (adj.).
4. High Chilled Water Return Press: If the chilled water return pressure is greater than 35 psig (adj.).

M. Condenser Water Temperature and Pressure Monitoring

1. The following temperatures and pressures will be monitored:

    a. Condenser water supply temperature.
    b. Condenser water supply pressure.
    c. Condenser water return temperature.
    d. Condenser water return pressure.

2. Alarms will be provided as follows:

    a. High Condenser Water Supply Temp: If the condenser water supply temperature is greater than 86°F (adj.).
    b. Low Condenser Water Supply Temp: If the condenser water supply temperature is less than 65°F (adj.).
    c. High Condenser Water Supply Press: If the condenser water supply pressure is greater than 35 psig (adj.).
    d. High Condenser Water Return Temp: If the condenser water return temperature is greater than 100°F (adj.).

e. Low Condenser Water Return Temp: If the condenser water return temperature is less than 75°F (adj.).
f. High Condenser Water Return Press: If the condenser water return pressure is greater than 35 psig (adj.).

N. Chilled Water System - Chiller Manager - Run Conditions

1. The chilled water system will be enabled to run whenever:

a. A definable number of chilled water coils need cooling.
b. The outside air temperature is greater than 54°F (adj.).
c. To prevent short cycling, the chiller manager will run for and be off for minimum adjustable times (both user definable).
d. Each chiller will run subject to its own internal safeties and controls.

2. Chiller Lead/Lag Operation

a. The two chiller trains, (each chiller and its associated support equipment), will operate in a lead/lag fashion. Chiller train will be referred to as chiller in this sequence.

3. The following setpoints are recommended values. All setpoints will be field adjusted during the commissioning period to meet the requirements of actual field conditions.
4. To prevent short cycling, there will be a user definable delay (adj.) between staging up or down, unless shutdown on safeties or failure. Each chiller will run subject to its own internal safeties and controls.
5. The lead chiller will run first.
6. On failure of the lead chiller, the lag chiller will run, and the lead chiller will turn off.
7. On increasing main chilled water supply temperature above 52°F (adj.), the lag chiller will stage on and run in unison with the lead chiller to maintain chilled water temperature setpoint.
8. The designated lead chiller will rotate upon one of the following conditions (user selectable):

a. manually through a software switch if chiller runtime (adj.) is exceeded daily, weekly, monthly.

9. The temperature and pressure will be monitored on both the supply and return to the building.

O. Alarms will be provided as follows:

1. Chiller 1 Failure: Commanded on, but the status is off.
2. Chiller 2 Failure: Commanded on, but the status is off.
3. Lead Chiller Failure: The lead chiller is in failure and the lag chiller is on.
4. High Main Chilled Water Supply Temp: If the main chilled water supply temperature is greater than 56°F (adj.).
5. Low Main Chilled Water Supply Temp: If the main chilled water supply temperature is less than 38°F (adj.).
6. High Main Chilled Water Supply Press: If the main chilled water supply pressure is greater than 35 psig (adj.).

7. High Main Chilled Water Return Temp: If the main chilled water return temperature is greater than 68°F (adj.).
8. Low Main Chilled Water Return Temp: If the main chilled water return temperature is less than 47°F (adj.).
9. High Main Chilled Water Return Press: If the main chilled water return pressure is greater than 35 psig (adj.).

P. Chiller Interface Monitor:

1. Current chiller status and operating conditions will be monitored through its communications interface port. The interface will monitor and trend the points as shown on the Points List.

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Chilled Water Return Temp					x				x		x
Chilled Water Supply Temp					x				x		x
Chilled Water Supply Temp Setpoint					x				x		x
Chiller kW					x				x		x
Condenser Refrigerant Pressure					x				x		x
Condenser Water Return Temp					x				x		x
Condenser Water Supply Temp					x				x		x
Evaporator Refrigerant Pressure					x				x		x
Oil Differential Pressure					x				x		x
Oil Temp					x				x		x
Operating Hours					x						x
Chilled Water Flow Status						x			x		x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Chiller Status						x			x		x
Condenser Water Flow Status						x			x		x
Totals	0	0	0	0	11	3	0	0	13	0	14

Total Hardware (0) Total Software (27)

3.6 CHILLER ROOM EMERGENCY REFRIGERATION PURGE SYSTEM SEQUENCE OF OPERATION

A. Emergency Refrigeration System Shutdown

1. The emergency refrigeration system shutdown manual control switches shall be provided at the equipment room exit doors.
2. Emergency shutdown switches shall be break-glass type for 'off only' control and shall be labeled 'emergency refrigeration equipment shutdown'.
3. Upon activation of the emergency shutdown switch, the chillers shall shut down and an alarm shall be initiated by the FMS.
4. The FMS shall stop the chilled water pumps, condenser water pumps, and cooling towers when the alarm condition is sensed.
5. The FMS contractor shall provide all required new devices, wiring and software necessary to accomplish the shutdown in accordance with uniform mechanical code requirements.

B. Refrigerant Leak Detection

1. Upon detection of a leak by the refrigerant monitor, local equipment room audible and visual alarms shall activate, remote alarm annunciation at the FMS shall occur, the refrigeration system equipment as listed above shall be deactivated, and the purge system sequence described below shall occur.

C. Emergency Refrigerant Purge System Switches

1. Manual control switches clearly identified as 'emergency refrigerant purge system' in break-glass enclosure shall be provided at the central plant exit doors.
2. When a switch is activated, the local equipment room audible and visual alarms shall activate, remote alarm annunciation at the FMS shall occur, and the purge system sequence described below shall occur.

D. Purge System

1. Upon activation of the purge system, the purge exhaust fan shall start and operate until the system is reset.

E. Central Control for Refrigerant Ventilation/Exhaust System Switches

1. A manual central control switch clearly identified 'central control for refrigerant exhaust system' shall be provided at the central plant entry door.
2. Central control switch shall be key operated, three (3) position type with pilot lights as required by UMC.
3. Operation of the equipment room ventilation/exhaust system central control switch shall be as follows:

    a. Switch 'off' - with switch in 'off' position, the refrigerant exhaust fan shall be deactivated, and 'red' pilot shall be lit indicating no exhaust fan airflow based on a differential pressure monitoring signal across exhaust fan.
    b. Switch 'on' (exhaust/purge operation) - with switch in 'on' position, the exhaust fan shall operate to provide purge exhaust for central plant, and 'green' pilot light shall be lit indicating exhaust fan airflow based on static pressure in the exhaust duct measured by the duct static pressure switch.
    c. Switch 'auto' - with switch in 'auto' position, the exhaust fan shall operate under normal FMS control (refer to exhaust fan sequence of operations).

3.7 HOT WATER PLANT CONTROL

A. Boiler System Run Conditions

1. The boiler system will be enabled to run whenever:

    a. A definable number of hot water coils need heating.
    b. Outside air temperature is less than 65°F (adj.).
    c. To prevent short cycling, the boiler system will run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.
    d. The boiler will run subject to its own internal safeties and controls.
    e. The boiler system will also run for freeze protection whenever the outside air temperature is less than 38°F (adj.).

B. Hot Water Pump Lead/Lag Operation

1. The hot water pumps will operate in a lead/lag fashion.
2. The lead pump will run first.
3. On failure of the lead pump, the lag pump will run, and the lead pump will turn off.
4. On decreasing hot water differential pressure, the lag pump will stage on and run in unison with the lead pump to maintain hot water differential pressure setpoint.
5. The designated lead pump will rotate upon one of the following conditions (user selectable):

    a. manually through a software switch
    b. if pump runtime (adj.) is exceeded daily, weekly, monthly.

6. The supply and return pressures will be monitored on each pump.

C. Alarms will be provided as follows:

1. Hot Water Pump 1

    a. Failure: Commanded on, but the status is off.
    b. Running in Hand: Commanded off, but the status is on.
    c. Runtime Exceeded: Status runtime exceeds a user definable limit.
    d. VFD Fault.
    e. High Return Pressure: If the pressure exceeds 35 psig (adj.).
    f. High Supply Pressure: If the pressure exceeds 35 psig (adj.).

D. Hot Water Bypass Valve - Loop Flow Control

1. The controller will measure hot water loop flow and, as the hot water loop flow rises above setpoint, the controller will modulate the hot water bypass valve open to maintain the loop flow setpoint.
2. Alarms will be provided as follows:

    a. High Hot Water Flow: If the hot water differential pressure is 25% (adj.) greater than setpoint.
    b. Low Hot Water Flow: If the hot water differential pressure is 25% (adj.) less than setpoint.

E. Hot Water Differential Pressure Control

1. The controller will measure hot water differential pressure and modulate the hot water pump VFDs in sequence to maintain its hot water differential pressure setpoint.
2. The following setpoints are recommended values. All setpoints will be field adjusted during the commissioning period to meet the requirements of actual field conditions.
3. The controller will modulate hot water pump speeds to maintain a hot water differential pressure of 12 psi (adj.). The VFDs minimum speed will not drop below 20% (adj.).
4. On dropping hot water differential pressure, the VFDs will stage on and run to maintain setpoint as follows:

    a. The controller will modulate the lead VFD to maintain setpoint.
    b. If the lead VFD speed is greater than a setpoint of 90% (adj.), the lag VFD will stage on.
    c. The lag VFD will ramp up to match the lead VFD speed and then run in unison with the lead VFD to maintain setpoint.

5. On rising hot water differential pressure, the VFDs will stage off as follows:

    a. If the VFDs speeds drops back to 60% (adj.) below setpoint, the lag VFD will stage off.
    b. The lead VFD will continue to run to maintain setpoint.

6. Alarms will be provided as follows:

    a. High Hot Water Differential Pressure: If 25% (adj.) greater than setpoint.
    b. Low Hot Water Differential Pressure: If 25% (adj.) less than setpoint.

F. Boiler Lead/Standby Operation

1. The boilers will operate in a lead/standby fashion when called to run and flow is proven. On a call for a boiler to run, an isolation valve will open, and the boiler will be allowed to run after valve position has been determined. Each boiler has 3 stages, which will enable in a linear fashion to control to setpoint.
2. The lead boiler will run first.
3. On failure of the lead boiler, the standby boiler will run, and the lead boiler will turn off.
4. The designated lead boiler will rotate upon one of the following conditions: (user selectable):

    a. manually through a software switch
    b. if boiler runtime (adj.) is exceeded daily, weekly, monthly.

5. Alarms will be provided as follows:

    a. Boiler Failure: Commanded on but the status is off.
    b. Boiler Running in Hand: Commanded off but the status is on.
    c. Boiler Runtime Exceeded: Status runtime exceeds a user definable limit.
    d. Lead Boiler Failure: The lead boiler is in failure and the standby boiler is on.

G. Hot Water Supply Temperature Setpoint Reset

1. The hot water supply temperature setpoint will reset based on outside air temperature.
2. As outside air temperature rises from 0°F (adj.) to 70°F (adj.) the hot water supply temperature setpoint will reset downwards by subtracting from 0°F (adj.) to 20°F (adj.) from the current boiler setpoint.

H. Primary Hot Water Temperature and Pressure Monitoring

1. The following temperatures and pressures will be monitored:

    a. Primary hot water supply temperature.
    b. Primary hot water supply pressure.
    c. Primary hot water return temperature.
    d. Primary hot water return pressure.

2. Alarms will be provided as follows:

    a. High Primary Hot Water Supply Temp: If greater than 200°F (adj.).
    b. Low Primary Hot Water Supply Temp: If less than 100°F (adj.).
    c. High Primary Hot Water Supply Press: If greater than 35 psig (adj.)
    d. High Primary Hot Water Return Press; If greater than 35 psig (adj.)

3. Boiler Hot Water Temperature and Pressure Monitoring
   The following temperatures and pressures will be monitored:

    a. Boiler hot water supply temperature.
    b. Boiler hot water supply pressure.
    c. Boiler hot water return temperature.

d. Boiler hot water return pressure

4. Alarms will be provided as follows:

a. High Hot Water Supply Temp: If greater than 200°F (adj.).
b. Low Hot Water Supply Temp: If less than 100°F (adj.).
c. High Hot Water Supply Pressure; If greater than 35 psig (adj.).
d. High Hot Water Return Pressure: If greater than 35 psig (adj.).

3.8 EMERGENCY BOILER SHUT-DOWN SWITCH SEQUENCE OF OPERATION

A. Boiler shutdown switches shall be installed at the boiler room door and shall kill power to the boilers when activated and close the isolation valves.

B. The FMS shall stop the primary and secondary pumps when the switch is activated and initiate an alarm.

3.9 VARIABLE SPEED DRIVE INTERFACE MONITOR

A. Current variable speed drive status and operating conditions will be monitored through its communications interface port. The interface will monitor and trend the points as shown on the Points List.

	Hardware Points				Software Points						
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Loop**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Current					x				x		x
DC Buss Voltage					x				x		x
Drive Status					x				x		x
External Reference Signal					x				x		x
kWh Counter					x						
MWh Counter					x						
Output Frequency					x				x		x
Output Voltage					x				x		x
Power					x				x		x
Runtime					x				x	x	x
Speed					x				x		x
Torque					x				x		x
VFD Temp					x				x		x
Fault Reset						x					x
AI1 Loss										x	
AI2 Loss										x	
Communication Error										x	
Current Measurement Fault										x	
DC Supply Phase										x	

	Hardware Points				Software Points						
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Loop**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
DI1 External Fault										x	
DI2 External Fault										x	
Drive ID Not Valid										x	
Earth Fault										x	
Embedded Fieldbus Config Error										x	
Encoder Error										x	
Excessive Output Current										x	
Forced Fault Trip										x	
Heat Sink is Overheated										x	
High DC Voltage										x	
Internal Config File Error										x	
Low DC Voltage										x	
Low Motor load - Underload										x	
Motor ID Run Failed										x	
Motor Overtemp										x	
Motor Phase Lost										x	
Motor Stall										x	
Output Power Wiring Error										x	
Overspeed										x	
Panel Comm is Lost										x	
Serial 1 Comm Error										x	
Short Circuit										x	
Thermistor Failure										x	
VSD OPEX Link - Fiber Comm Issue										x	
VSD OPEX Power - OINT Low Voltage										x	
Totals	**0**	**0**	**0**	**0**	**13**	**1**	**0**	**0**	**11**	**31**	**12**

Total Hardware (0) **Total Software (56)**

3.10 CENTRAL REFRIGERATION SYSTEMS

A. Time Schedule: Start and stop condensing water pump.

B. Condensing Water Pump: Allow start on proof of water in cooling tower sump and on outdoor temperature above 50 degrees F.

C. Energize chilled water pump to start and allow cooling tower fans to start when condensing water pump started.

D. When chilled water pump starts, open chiller control valve. Modulate chiller control valve to maintain constant flow through chiller.

E. When flow switches prove chilled water flow and condensing water flow, allow refrigeration machine to start.

F. Maintain minimum condenser water temperature of 75 degrees F by modulating tower bypass valve and cycling cooling tower fans.

G. Maintain temperature in cooling tower sump of 40 degrees F by cycling electric sump heaters. Outdoor thermostat set at 35 degrees F activates electric heat tracing.

H. Thermostat in cooling tower sump, set at 35 degrees F, open drain lines, closes make-up valve, and deactivates sump heaters and piping electric heat tapes.

I. Display:
   1. System graphics.
   2. Condensing water pump on/off indication.
   3. Chilled water pump on/off switch.
   4. Chiller on/off indication.
   5. Condensing-water temperature - supply and return.
   6. Chilled-water temperature - supply and return.
   7. Chiller condensing-water control point adjustment.
   8. Common chilled-water control point adjustment.
   9. Low level cooling tower sump alarm.
   10. Expansion tank low-level alarm.
   11. Cooling tower fan on/off indication.
   12. Cooling tower sump heater on/off indication.
   13. Cooling tower dump indication.
   14. Chilled water control point adjustment.
   15. Condensing water pump on/off/auto switch.
   16. Chilled water pump on/off/auto switch.
   17. Chiller on/off/auto switch.

3.11 CENTRAL FAN SYSTEMS

A. Time Schedule: Start and stop supply and return fans. Determine fan status by current sensing devices. When fan fails to start as commanded, signal alarm.

B. Safety Devices:

   1. Freeze Protection: Stop fans and close outside air dampers when temperature downstream of preheat coil is below 37 degrees F; signal alarm.
   2. High Temperature Protection: Stop fans and close outside dampers when temperature in return air is above 300 degrees F; signal alarm.
   3. Smoke Detector: Stop fans, close outside dampers, and close smoke dampers when smoke is detected; signal alarm.

C. Preheat Coil:

1. When fan is not running, and outside air temperature is below 40 degrees F, fully open preheat coil valve to heating.
2. When fan is running, maintain minimum mixed air temperature of 55 degrees F by modulating preheat coil valve.

D. Outside Air Damper: When supply fan is running, open outside air damper to minimum position.

E. Outside Air Control for Variable Air Volume Systems: Outside air measuring and modulation device located in outside air opening or outside air ductwork, through the DDC controller, maintains fixed minimum outside air quantity independent of system air flow.

F. Humidifier: When supply fan is running, allow humidifier to operate.

G. Outside, Return, and Relief Dampers:

1. When supply fan is not running, outside and relief dampers are closed and return damper is open.
2. When supply fan is running, dampers are controlled and operate with outside and relief dampers opening and return damper closing.
3. For cooling and outside air temperatures below 55 degrees F, modulate dampers to maintain mixed air temperature of 55 degrees F or higher.
4. For cooling and outside air temperatures above 55 degrees F outside and relief dampers are open and return damper is closed.
5. For cooling and outside air temperatures above 55 degrees F compare return and outside air enthalpies. When return air enthalpy is lower, drive outside damper to minimum, close relief damper, and open return damper.
6. For outside air temperatures above 79 degrees F, drive outside damper to minimum, close relief damper, and open return damper.
7. For heating, drive outside damper to minimum, close relief damper, and open return damper.
8. Modulate mixed air dampers, preheat coil valve, face and bypass dampers, and cooling coil valve in sequence to maintain supply air temperature.

H. Dual Duct System:

1. Control hot deck by modulating heating coil valve in accordance with outdoor temperature reset schedule.
2. Control hot deck at maximum 135 degrees F at outdoor temperature of -30 degrees F, and minimum 75 degrees F at outdoor temperature of 75 degrees F, with straight line relationship between.
3. Maintain constant cold deck temperature of 55 degrees F by modulating cooling coil valve.
4. Reset hot and cold deck temperatures. Room thermostat with highest heating demand resets hot deck control temperature. Room thermostat with highest cooling demand resets cold deck control temperature.

I. Induction System:

1. Control hot deck by modulating heating coil valve in accordance with outdoor temperature reset schedule.

2. Control zone temperature at maximum 135 degrees F at outdoor temperature of -30 degrees F, and minimum 55 degrees F at outdoor (solar compensated) temperature of 75 degrees F. Use straight-line relationship between high and low temperatures.

J. Maintain constant supply static pressure as determined by TAB contractor by modulating supply fan VFD in sequence. Locate sensor 2/3 of the way downstream of supply fan in supply air duct.

K. Maintain constant building pressure of +0.05 inches wg measured at grade by modulating return fan VFD.

L. Reset supply static pressure lower until one VAV box damper is full open.

M. Display:
1. System graphic.
2. System on/off indication.
3. System day/night mode.
4. System fan on/off indication.
5. Return fan on/off indication.
6. Preheat coil pump on/off indication.
7. Spray pump on/off indication.
8. Outside air temperature indication.
9. Mixed air temperature indication.
10. Fan discharge air temperature indication.
11. Reheat zone air temperature indication.
12. Return humidity indication.
13. Fan discharge temperature control point adjustment.
14. Return humidity control point adjustment.
15. Reheat zone control point adjustment.
16. Supply static pressure indication.
17. Supply static pressure control point adjustment.
18. Building static pressure indication.
19. Building static pressure control point adjustment.
20. Outside air flow rate.
21. System on/off auto switch.
22. System day/night/auto switch.
23. Supply fan on/off switch.
24. Return fan on/off/auto switch.
25. Preheat coil pump on/off switch.
26. Spray pump on/off auto switch.

3.12 EXHAUST FANS

A. On room temperature above 85°F (adj.) open intake dampers and start exhaust fans.

B. On room temperatures above 90°F (adj.) signal alarm.

3.13 EXCESS PRESSURE CONTROLS

A. Maintain constant pressure differential between supply and return lines by varying pump speed through variable speed drive control.

3.14 FAN COIL UNITS

A. Thermostat opens and closes two-way heating water and chilled water control valves to maintain space temperature setpoints. Space temperature setpoints shall setback for heating and set up for cooling during unoccupied hours.

B. For heating and cooling fan coil units with fan speed control during heating cycle, increase fan speed as space temperature falls below thermostat setting, when hot water is available. During cooling cycle, increase fan speed as space temperature rises above thermostat setting, when chilled water is available.

3.15 HEATING COILS

A. Thermostat opens and closes two-way heating water control valve or stages electric heating to maintain space temperature setpoint. Space temperature setpoint shall setback during unoccupied hours.

3.16 HUMIDIFIERS

A. When fan is running and airflow switch proves airflow, line voltage room humidistat maintains humidity level of 30 percent RH by cycling unit fan and opening modulating two-way steam valve.

3.17 REFRIGERATION SYSTEMS

A. Maintain constant supply air duct temperature of 55°F by cycling refrigeration system and signaling step capacity, minimum of two steps.

3.18 AIR TERMINAL UNITS

A. Single Duct Variable Volume Air Terminal Units (Cooling Only):

1. Occupied Cycle: On rise in space temperature above cooling setpoint, air terminal unit damper modulates open to maximum air quantity. As space temperature drops below cooling setpoint, air terminal unit damper modulates closed to minimum air quantity.
2. Unoccupied Cycle: Air terminal damper is normally closed.

B. Single Duct Variable Volume Air Terminal Units (with Heating Coil):

1. Occupied Cycle: On rise in space temperature above cooling setpoint, air terminal unit damper modulates open to maximum air quantity. As space temperature drops below cooling setpoint, air terminal unit damper modulates closed to its minimum air quantity. As space temperature continues to fall to heating setpoint, air terminal unit damper modulates to heating minimum air quantity. Heating coil

will stage on electric heat or drive open heating coil control valve to maintain space heating setpoint. If the heat source is fully on or open and the space temperature continues to fall, the VAV damper shall increase airflow until the space heating setpoint is satisfied.
2. Unoccupied Cycle: Air terminal damper is normally open. Heating is staged to maintain reduced space temperature. Heating coil control valve is normally closed.

C. Dual Duct Variable Volume Air Terminal Units:

1. Occupied Cycle: On rise in space temperature above cooling setpoint, air terminal unit cooling damper modulates open to maximum air quantity. Heating damper is fully closed. As space temperature drops below cooling setpoint, air terminal unit cooling damper modulates to minimum air quantity. As space temperature continues to drop to heating setpoint, air terminal unit heating damper modulates open to maximum air quantity.
2. Unoccupied Cycle: Cooling damper normally open. Heating damper normally closed.

D. Parallel Fan Powered Variable Volume Air Terminal Units:

1. Occupied Cycle: On rise in space temperature above cooling setpoint, air terminal unit damper modulates open to maximum cooling air quantity. As space temperature drops below cooling setpoint, air terminal unit damper modulates closed to its minimum cooling air quantity. As space temperature continues to fall, unit fan is energized. Upon further drop in space temperature, unit fan modulates to maximum heating air quantity. If the space temperature continues to fall, heating coil will stage on electric heat or drive open the heating coil control valve to maintain space temperature setpoint.
2. Unoccupied Heating Cycle: Air terminal unit damper modulates fully closed. Terminal unit fan and heating coil cycle to maintain reduced space temperature setpoint.

E. Series Fan Powered Variable Volume Air Terminal Units:

1. Occupied Cycle: Unit fan operates continuously. On rise in space temperature above cooling setpoint, air terminal unit damper modulates to maximum cooling air quantity. As space temperature drops below cooling setpoint, air terminal unit damper modulates to minimum cooling air quantity. As space temperature continues to fall, heating coil will stage on electric heat or drive open heating coil control valve to maintain space temperature setpoint.
2. Unoccupied Cycle: Air terminal unit damper modulates fully closed. Terminal unit fan and heating coil cycle to maintain reduced space temperature.

3.19 ELECTRIC UNIT HEATERS

A. Single temperature electric room thermostat maintains constant space temperature of 68°F (adj.) by cycling unit fan motor.

B. Single temperature thermostat on return heating water line de-energizes unit on temperatures below 95°F (adj.).

C. Single temperature room thermostat set at 68°F (adj.) maintains constant space temperature by cycling unit fan motor and energizing electric heating elements. Integral thermostat continues fan operation until element temperature falls below 100°F.

END OF SECTION 230993

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydronic specialty valves.
2. Air vents.
3. Expansion tanks and fittings.
4. Air/dirt separators and purgers.
5. Strainers.
6. Flexible connectors.

1.2 ACTION SUBMITTALS

A. Product Data (PD): For each type of product:

1. Submit manufacturer's catalog information with valve data and ratings for each service.
2. Include construction details and material descriptions for hydronic piping specialties.
3. Include rated capacities, operating characteristics, and furnished specialties and accessories.
4. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

B. Manufacturer's Installation Instructions:

1. Submit hanging and support methods, joining procedures.

C. Coordination Drawings:

1. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

D. Operation and Maintenance Data:

1. Include in final O&M Manuals provided to CAWCD.

E. Chilled Water Buffer Tank and Expansion Tank Shop Drawings and Size Calculations

1. Provide ASHRAE sizing calculations for CAWCD approval for Chilled Water Buffer Tanks and Hydro-Pneumatic Expansion Tanks.
2. Provide tank shop drawings for CAWCD approval

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.4 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators in accordance with ASME BPVC, Section IX.

B. Pressure-relief and safety-relief valves and pressure vessels bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME BPVC, Section VIII, Division 1.

1.5 QUALIFICATIONS

A. Manufacturer:

1. Company specializing in manufacturing Products specified in this section with five years documented experience.
2. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare specialties for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Provide temporary protective coating on cast iron and steel valves if required.

B. Use the following precautions during storage:

1. Store specialties indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store specialties off the ground in watertight enclosures.

1.7 WARRANTY

A. Furnish five-year manufacturer warranty for piping specialties. Warranty shall begin at date of start-up.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Manual Balancing Valves:

1. Manufacturers: Subject to compliance with requirements:

    a. NIBCO INC.
    b. Apollo Valves; a part of Aalberts Integrated Piping Systems
    c. Victaulic Company
    d. WATTS; A Watts Water Technologies Company
    e. Nexus Valve, Inc.; Aalberts Hyrdonic Flow Control
    f. Or CAWCD Approved Equal

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

B. Cast-Iron or Steel, Calibrated-Orifice, Manual Balancing Valves:

1. Manufacturers: Subject to compliance with requirements:

    a. NIBCO INC.
    b. Apollo Valves; a part of Aalberts Integrated Piping Systems
    c. Victaulic Company
    d. WATTS; A Watts Water Technologies Company
    e. Nexus Valve, Inc.; Aalberts Hyrdonic Flow Control
    f. Or CAWCD Approved Equal

2. Body: Cast-iron or steel body, ball, butterfly, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass- and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.

C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements:

    a. NIBCO INC.
    b. Apollo Valves; a part of Aalberts Integrated Piping Systems
    c. Victaulic Company
    d. WATTS; A Watts Water Technologies Company
    e. Or CAWCD Approved Equal

2. Body: Bronze or brass.
3. Disc: Brass or EPDM.
4. Seat: Brass or steel.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPDM.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size and Capacity: As indicated on Drawings.
11. Operating Pressure: Factory set and field adjustable.

D. Diaphragm-Operated Pressure-Relief Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements:

    a. Apollo Valves; a part of Aalberts Integrated Piping Systems
    b. Bell & Gossett; a Xylem brand
    c. WATTS; A Watts Water Technologies Company
    d. Zurn Industries, LLC
    e. Or CAWCD Approved Equal

2. Body: Bronze or brass.
3. Disc: Brass or steel.
4. Seat: Brass or steel.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPDM.
7. Valve Seat and Stem: Noncorrosive.
8. Valve Size, Capacity, and Operating Pressure: Comply with ASME BPVC, Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Automatic Flow Limiting Valves:

1. Manufacturers: Subject to compliance with requirements:

    a. NIBCO INC.
    b. Apollo Valves; a part of Aalberts Integrated Piping Systems
    c. Bell & Gossett; a Xylem brand
    d. Victaulic Company
    e. WATTS; A Watts Water Technologies Company
    f. Griswold Controls
    g. Hays Fluid Controls
    h. Nexus Valve, Inc.; Aalberts Hyrdonic Flow Control
    i. Or CAWCD Approved Equal

2. Body: Brass or ferrous metal.
3. Combination Assemblies: Include bronze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.
5. Size and Capacity: For each application, provide a valve with rated capacity equal to or greater than capacity of device being served.
6. Performance: Allow specified flow within plus or minus 10 percent, regardless of system pressure fluctuations.
7. Minimum CWP Rating: 175 psig.
8. Maximum Operating Temperature: 250 deg F.

2.2 AIR VENTS

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements:

    a. Apollo Valves; a part of Aalberts Integrated Piping Systems
    b. Bell & Gossett; a Xylem brand
    c. Taco Comfort Solutions
    d. WATTS; A Watts Water Technologies Company
    e. Or CAWCD Approved Equal

2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements:

    a. Apollo Valves; a part of Aalberts Integrated Piping Systems
    b. Bell & Gossett; a Xylem brand
    c. Taco Comfort Solutions
    d. WATTS; A Watts Water Technologies Company
    e. Or CAWCD Approved Equal

2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/4.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

2.3 EXPANSION TANKS AND FITTINGS

A. Ensure hydro-pneumatic expansion tank(s) are sized according to ASHRAE Handbook calculations. Provide shop drawing of hydro-pneumatic tanks for CAWCD approval prior to installation.

B. Diaphragm-Type ASME Expansion Tanks:

1. Manufacturers:

    a. AMTROL, Inc.
    b. Armstrong Fluid Technology
    c. Bell & Gossett; a Xylem brand
    d. Taco Comfort Solutions
    e. Or CAWCD Approved Equal

2. Tank: Welded steel, rated for 125 psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled in accordance with ASME BPVC, Section VIII, Division 1.
3. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

C. Bladder-Type ASME Expansion Tanks:

1. Manufacturers:

    a. AMTROL, Inc.
    b. Armstrong Fluid Technology
    c. Bell & Gossett; a Xylem brand
    d. Taco Comfort Solutions
    e. Or CAWCD Approved Equal

2. Tank: Welded steel, rated for 125 psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled in accordance with ASME BPVC, Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity. Field-replaceable bladder.
4. Sight glass.
5. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. Diaphragm-Type Non-ASME Expansion Tanks:

1. Manufacturers:

    a. AMTROL, Inc.
    b. Armstrong Fluid Technology
    c. Bell & Gossett; a Xylem brand
    d. Taco Comfort Solutions
    e. Or CAWCD Approved Equal

2. Tank: Carbon steel, non-ASME constructed, rated for minimum 100 psig working pressure at minimum 200 deg F maximum operating temperature.
3. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.4 AIR/DIRT SEPARATORS AND PURGERS

A. Coalescing-Type Air and Dirt Separators:

1. Manufacturers:

a. AMTROL, Inc.
b. Armstrong Fluid Technology
c. Bell & Gossett; a Xylem brand
d. Taco Comfort Solutions
e. Spirotherm, Inc.
f. Or CAWCD Approved Equal

2. Tank: Fabricated steel tank; ASME constructed and stamped for 125 psig working pressure and 270 deg F maximum operating temperature.
3. Coalescing Medium: Copper or stainless steel.
4. Air Vent: Threaded to top of separator.
5. Inline Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; Class 150 flanged connections for NPS 2-1/2 and larger.
6. Blowdown Connection: Threaded to bottom of separator.
7. Size: Match system flow capacity.

B. Air Purgers:

1. Manufacturers:

a. Bell & Gossett; a Xylem brand
b. Griswold Controls, LLC
c. Spirotherm, Inc.
d. Taco Comfort Solutions
e. Or CAWCD Approved Equal

2. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
3. Maximum Working Pressure: 150 psig.
4. Maximum Operating Temperature: 250 deg F.

2.5 STRAINERS

A. Y-Pattern Strainers:

1. Manufacturers:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems
b. Caleffi North America

c. Victaulic Company
d. WATTS; A Watts Water Technologies Company
e. Or CAWCD Approved Equal

2. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen: Stainless steel, 40-mesh strainer, or perforated stainless steel basket.
5. CWP Rating: 125 psig.

B. Basket Strainers:

1. Manufacturers:

a. Metraflex Company
b. Titan Flow Control, Inc.
c. WATTS; A Watts Water Technologies Company
d. Zurn Industries, LLC
e. Or CAWCD Approved Equal

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

C. Strainer Drain Line Requirements

1. For Strainers on NPS 1" and larger, strainer shall be provided with ball valve installed on drain port
2. For strainers on NPS 2-1/2" and larger, strainer drain line must also be plumbed to floor drain or as otherwise approved by CAWCD.

2.6 FLEXIBLE CONNECTORS

A. Stainless Steel Bellows, Flexible Connectors:

1. Manufacturers:

a. Flexicraft Industries
b. Flo Fab Inc
c. Metraflex Company
d. Or CAWCD Approved Equal

2. Body: Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
3. End Connections: Threaded or flanged to match equipment connected.

4. Performance: Capable of 3/4-inch misalignment.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 deg F.

B. Spherical, Rubber, Flexible Connectors:

1. Manufacturers:

a. Flexicraft Industries
b. Flo Fab Inc
c. Metraflex Company
d. Mason Industries
e. Or CAWCD Approved Equal

2. Body: Fiber-reinforced rubber body.
3. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
4. Performance: Capable of misalignment.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine threads on all devices for form and cleanliness.

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

D. Do not attempt to repair defective piping specialties; replace with new devices. Remove defective piping specialties from site.

3.2 INSTALLATION OF VALVES

A. Install manual balancing valve at each branch connection to return main.

B. Install manual balancing valve or automatic flow limiting valve in the return pipe of each heating or cooling terminal.

C. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

D. Install pressure-relief and safety-relief valves at hot-water generators and elsewhere as required by ASME BPVC. Pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME BPVC, Section VIII, Division 1, for installation requirements.

3.3 INSTALLATION OF HYDRONIC SPECIALTIES

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only.

1. Provide air outlet drain line full size of air outlet to floor drain or to other point indicated on Drawings.

C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

D. Install diaphragm- or bladder-type expansion tanks on the floor.

E. Vent and purge air from hydronic system and ensure that expansion tank is properly pre-charged with air to equal the make-up water pressure before connecting the tank to the system.

END OF SECTION 232116

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit data on pipe materials and fittings. Submit manufacture’s catalog information.
2. For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.

B. Shop Drawings (SD):

1. Submit layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment. Submitting project design drawings as shop drawings will not be acceptable by CAWCD.

1.3 QUALITY ASSURANCE

A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.4 QUALIFICATIONS

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

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

B. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.6 FIELD MEASUREMENTS

A. Verify all field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410a: Refer to ASME B31.5 for refrigerant test pressures.

B. Suction Lines for Air-Conditioning Applications: 185 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tubing: ASTM B 280, Type ACR.

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

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

D. Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. 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.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.

2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 115-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 450 psig.

H. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

I. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

J. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

K. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.

3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: 40 tons.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

L. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: 40 tons.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

M. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.4 REFRIGERANTS

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

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Genetron Refrigerants; Honeywell, Inc.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410a: Difluoromethane, Pentafluoroethane

C. ASHRAE 34, R-32: Difluoromethane

D. ASHRAE 34, R-452b: Difluoromethane, Pentafluoroethane, 2,3,3,3-Tetrafluoro-1-Propene

E. ASHRAE 34, R-454b: Difluoromethane, 2,3,3,3-Tetrafluoro-1-Propene

F. ASHRAE 34, R-466a: Difluoromethane, Pentafluoroethane, Trifluoroiodomethane

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

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. Suction Lines NPS 2 to NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Hot-Gas and Liquid Lines for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

D. Hot-Gas, Liquid, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

E. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at strainers if they are not an integral part of strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve on systems with multiple thermostatic expansion valves. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Compressor.
4. Hot-gas bypass valves.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve**,** and in the suction line at the compressor.

L. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

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

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. Refer to Section 230900 and Section 230993 for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install

access doors or panels as specified in Section 083113 if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:

1. Install 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.

P. 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.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves according to Section 220553.

S. Install sleeves for piping penetrations of walls, ceilings, and floors.

T. Install sleeve seals for piping penetrations of concrete walls and slabs.

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

3.4 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Install hangers, supports, and anchors as specified in Section 230529.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal run 20 feet or longer.

3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

D. Support multi-floor vertical runs at least at each floor.

3.6 PIPE INSULATION

A. Install refrigerant pipe insulation as specified in Section 230700.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping and specialties. 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 Article 2.1 "Performance Requirements".

    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.

3.8 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 minimum 500 micrometers. If vacuum holds for 24 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.

3.9 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 232300

SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. System cleaner.
2. Closed system treatment (water).
3. Condenser water system treatment.
4. Open system treatment.
5. Chemical feeder equipment including associated feeders, pumps, tanks, controls, meters, and valves.
6. Water softeners.
7. Stainless-steel pipes and fittings.
8. Test equipment.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:

a. Bypass feeders.
b. Water meters.
c. Chemical test equipment.
d. Chemical material safety data sheets.
e. Electrical characteristics and connection requirements.

2. Manufacturer's Installation Instructions: Submit placement of equipment in systems, piping configuration, and connection requirements.

B. Shop Drawings (SD):

1. Indicate system schematic, equipment locations, and controls schematics, maintenance space required, electrical characteristics and connection requirements. Include plans, elevations, sections, details, and attachments to other work.

C. Closeout Submittals (CS:)

1. Operation and Maintenance Data: Submit data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations. Also include O&M data in final O&M Manuals provided to CAWCD.

a. Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article.
b. Cleaning and flushing piping procedures plan.

2. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

D. Quality Control Reports (QCR)

1. Manufacturers Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
2. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
3. Water Analysis: Illustrate water quality available at Project site.

E. Water-Treatment Program:

1. Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
2. Cleaning and flushing piping procedures plan.

1.3 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities in Arizona or within 100 miles of Project with water analysis laboratories and full-time service personnel.

B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.6 WARRANTY

A. Furnish two-year manufacturer warranty for pumps, valves, and water meters. Warranty period shall begin at date of start-up.

1.7 MAINTENANCE SERVICE

A. Provide service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for cooling, chilled-water piping, and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

B. Furnish laboratory and technical assistance services during this maintenance period.

C. Furnish onsite inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program and make recommendations in writing based upon these inspections.

D. For the first year of operation at eight-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.

1.8 MAINTENANCE MATERIALS

A. Furnish chemicals for treatment and testing during warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide system to treat water available at project site to maintain the following characteristics of water in closed systems:
1. pH: Maintain a value within 9.0 to 10.5.
2. "P" Alkalinity: Maintain a value within 100 to 500ppm.
3. Boron: Maintain a value within 100 to 200 ppm.
4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
6. TDS: Maintain a maximum value of 10 ppm.
7. Ammonia: Maintain a maximum value of 20 ppm.
8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
9. Microbiological Limits:

a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.

b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

B. Cleaning and flushing procedures shall continue until M-alkalinity of the chilled water distribution piping loop matches the make-up water alkalinity.

C. Provide system to treat water available at project site to maintain the following characteristics of water in open systems:

1. pH: Maintain a value within 8.0 to 9.1.
2. "P" Alkalinity: Maintain a maximum value of 100 ppm.
3. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
4. Soluble Copper: Maintain a maximum value of 0.20 ppm.
5. TDS: Maintain a maximum value of 10 ppm.
6. Ammonia: Maintain a maximum value of 20 ppm.
7. Free “OH” Alkalinity: Maintain a maximum value of 0 ppm.
8. Microbiological Limits:

a. Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/ml.
b. Total Anaerobic Plate Count: Maintain a maximum value of 1,000 organisms/ml.
c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

9. Polymer Testable: Maintain a minimum value within 10 to 40.

2.2 Cleaning and flushing procedures shall continue until M-alkalinity of the water distribution piping loop matches the make-up water alkalinity.

2.3 SYSTEM CLEANER

A. Manufacturer:

1. As recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in “Performance Requirements” Article.

B. Product Description: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.

2.4 CLOSED SYSTEM TREATMENT (WATER)

A. Manufacturer:

1. As recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in “Performance Requirements” Article.

B. Sequestering agent to reduce deposits and adjust pH.

C. Corrosion inhibitors

D. Conductivity enhancers

2.5 CONDENSER WATER SYSTEM TREATMENT (COOLING TOWERS)

A. Manufacturer:

1. As recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in “Performance Requirements” Article.

B. Sequestering agent to inhibit scaling: As recommended by water treatment company.

C. Acid to reduce alkalinity and pH

D. Corrosion inhibitor

E. Biocide

2.6 OPEN SYSTEM TREATMENT - (HUMIDIFIERS, AIR WASHERS, EVAPORATIVE CONDENSERS, SMALL COOLING TOWERS, LIQUID COOLERS)

A. Manufacturer:

1. As recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in “Performance Requirements” Article.

B. Sequestering agent to inhibit scaling and corrosion inhibitor

C. Biocide

2.7 BY-PASS (POT) FEEDER

A. Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4-inch bottom inlet and top side outlet. Provide threaded fill cap with gasket seal and diaphragm arranged to lock the top onto the feeder when exposed to system pressure in the vessel. Provide a NPS 3/4-inch quarter-turn valve on inlet and outlet.

1. Capacity: 2 gallons or 5 gallons.
2. Minimum Working Pressure: 175 psig.

2.8 DRIP FEEDER

A. Plastic reservoir with coil of capillary tubing with probe, weights, charging syringe, and clip.

2.9 SOLUTION METERING PUMP

A. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and relief valve.

B. Electrical Characteristics:

1. 120 volts, single phase, 60 Hz.
2. Cord and Plug: Furnish unit with cord and plug, length as required, for connection to electric wiring system including grounding connector.

2.10 SOLUTION TANKS

A. Minimum 30 gallon capacity, polyethylene, self-supporting, 5 gallon graduated markings; molded fiberglass cover with recess for mounting pump, agitator, and liquid level switch.

2.11 AGITATOR

A. Totally enclosed, Explosion-proof electric motor, stainless steel clamp and motor mount, Type 316 stainless steel shaft and propeller.

B. Electrical Characteristics:

1. 120 volts, single phase, 60 Hz.
2. Cord and Plug: Furnish unit with cord and plug, length as required, for connection to electric wiring system including grounding connector.

2.12 LIQUID LEVEL SWITCH

A. Polypropylene housing with integrally mounted PVC air trap, receptacles for connection to metering pump, and low level alarm.

2.13 CONDUCTIVITY CONTROLLER

A. Packaged monitor controller with solid state circuiting, five percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control function light, output to control circuit and recorder.

2.14 WATER METER

A. Displacement type cold-water meter with sealed, tamper-proof magnetic drive, impulse contact register.

2.15 SOLENOID VALVES

A. Forged brass body globe pattern, normally open or closed as required, explosion- proof and watertight solenoid enclosure where required, and continuous duty coil.

2.16 TIMERS

A. Electronic timers, infinitely adjustable over full range, 150 second and five minute range, mounted together in cabinet with hands-off-automatic switches and status lights.

2.17 WATER SOFTENERS

A. Performance:

1. Softening Capacity: As scheduled.
2. Service Flow: As scheduled.
3. Electrical Characteristics: 120 volts, single phase 60 Hz.

B. Softener Tank: Glass fiber reinforced plastic tank, size and resin capacity as scheduled.

C. Brine Tank: Glass fiber reinforced plastic tank, size and salt capacity as scheduled.

D. Control: Brass control valve cycled to regenerate from one to twelve day period or after adjustable metered quantity of water flow.

2.18 TEST EQUIPMENT

A. Furnish white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titration burettes and associated reagents.

B. Furnish following test kits:

1. Alkalinity titration test kit.
2. Chloride titration test kit.
3. Sulphite titration test kit.
4. Total hardness titration test kit.
5. Low phosphate test kit.
6. Conductivity bridge, range 0 - 10,000 micro-ohms.
7. Creosol red pH slide, complete with reagent.
8. Portable electronic conductivity meter.
9. High nitrite test kit.

2.19 STAINLESS-STEEL PIPES AND FITTINGS

A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.

B. Stainless-Steel Fittings: Comply with ASTM A 815, Type 316, Grade WP-S.

C. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig SWP and 600-psig CWP ratings.

D. Three-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig SWP and 600-psig CWP rating.

PART 3 - EXECUTION

3.1 PREPARATION

A. Operate, fill, start and vent systems prior to cleaning. Use water meter to record capacity in each system. Place terminal control valves in open position during cleaning.

3.2 CLEANING

A. Concentration:

1. As recommended by manufacturer.
2. One pound per 100 gallons of water contained in the system.
3. One pound per 100 gallons of water for hot systems and one pound per 50 gallons of water for cold systems.
4. Fill steam boilers only with cleaner and water.

B. Hot Water Heating Systems:

1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
3. Circulate for 6 hours at design temperatures, then drain.
4. Refill with clean water and repeat until system cleaner is removed.

C. Chilled Water Systems:

1. Circulate for 48 hours, then drain systems as quickly as possible.
2. Refill with clean water, circulate for 24 hours, then drain.
3. Refill with clean water and repeat until system cleaner is removed.

D. Use neutralizer agents on recommendation of system cleaner supplier and acceptance of CAWCD.

E. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.

F. Remove, clean, and replace strainer screens.

G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.3 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

3.4 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system.

1. Install isolating and drain valves and interconnecting piping. Install around balancing valve downstream of circulating pumps as indicated on Drawings.
2. Install water meter in makeup water supply.
3. Install full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
4. Install a swing check on inlet after the isolation valve.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

C. Install 3/4-inch water coupon rack around circulating pumps with space for 4 test specimens.

3.5 OPEN SYSTEM TREATMENT

A. Provide two glass mesh feeder bags for each unit, suspended in sump, filled with sequestering agent.

B. Provide drip feeder to feed sequestering agent into sump. Interlock solenoid valve on drip system with circulating pump.

C. Provide 1/2-inch bleed-off complete with globe valve piped to drain. Locate bleed-off above flood line. Provide solenoid valve wired to pump.

D. Provide conductivity controller to sample sump water and operate bleed-off solenoid valve. Activate with pump. Pipe to drain.

3.6 CONDENSER WATER SYSTEMS (COOLING TOWERS)

A. Provide automatic condenser water control systems for inhibitor feed, blow-down, and biocide feeds.

1. Provide meter activated inhibitor application.
2. Provide conductivity activated blow-down.
3. Provide meter fed biocide with blow-down locked out to ensure biocide retention time.

B. Incorporate solid state integrated circuits and digital LED displays, in NEMA 250 Type 12 steel enclosure. Provide lockable door with gaskets.

C. Base dissolved solids control on conductivity and include:

1. LED digital readout display (micro-ohm/cm).
2. Temperature compensated sensor probe adaptable to sample stream manifold.
3. High, low, normal conductance indicator lights (LED).
4. High or low conductance alarm light (flash or steady switch), trip points field adjustable. Furnish flash or steady switch with silence position.
5. Illuminated legend indicating "ALARM" whenever alarm condition exists.
6. Hand-off-automatic switch for solenoid bleed valve.
7. Illuminated legend indicating "BLEED" when valve is operated.
8. Adjustable hysteresis or dead-band (internal).

D. Base inhibitor feed control on make-up volume and include:

1. Solid state counter (1-15 field selectable).
2. Solid state timer (adjustable 1/4 to 5 minutes).
3. Test switch.
4. Hand-off-automatic switch for chemical pump.
5. Illuminated legend indicating "FEED" when pump is activated.
6. Solid state lockout timer (adjustable 1/4 to 3 hours) and indicator light. Lockout timer to deactivate pump and activate alarm circuits.
7. Panel total (quantity of makeup), Electro-mechanical type.

E. Biocide programmer to include:

1. 24-hour timer with 14-day skip feature.
2. Precision solid state bleed lockout timer (0-9 hours) and biocide pump timer (0 - 2-1/4 hours), clock controlled.
3. Solid state alternator to enable use of two different formulations.
4. Digital display of time of day (24 hours).
5. LED display of day of week (14 days).
6. Fast and slow clock set controls (internal).
7. Battery back-up so clock is not disturbed by power outages, quartz timekeeping accuracy.
8. Hand-off-automatic switches for biocide pumps.
9. Illuminated legend indicating "BIOCIDE A" or "BIOCIDE B" when pump is activated.

F. Provide water meter on system make-up, wired to control system.

G. Provide solution pumps to feed sequestering agent and corrosion inhibitor from solution tank into condenser water supply to tower. Provide agitator in accordance with treatment suppliers recommendations.

H. Provide conductivity controller to sample condenser water and operate solenoid bleed valve and piping to blow-down controller. Wire sampler to open when condenser water pump is operating.

I. Introduce biocide to tower by continuous feed with solution pump or solenoid valve on tank (chlorine).

J. Provide liquid level switch in each solution tank to de-activate solution pump and agitator, and signal mechanical alarm system.

K. Install 3/4-inch water coupon rack around circulating pumps with space for 4 test specimens.

3.7 FIELD QUALITY CONTROL

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

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested, and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials and retest piping until no leaks exist.

D. Remove and replace malfunctioning units and retest as specified above.

3.8 DEMONSTRATION

A. Furnish training course for operating personnel, instruction to include installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at startup of systems. Notify CAWCD of time needed for course one month prior to incorporate into project schedule.

END OF SECTION 232500

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.

1.2 ACTION SUBMITTALS

A. Product Data (PD): Submit manufacturer data for the following products.

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Submit delegated duct design as specified in “Performance Requirements” Article.
2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Factory and shop-fabricated ducts and fittings.
4. Duct layout indicating sizes, configuration, and static-pressure classes.
5. Elevation of top of ducts.
6. Dimensions of main duct runs from building grid lines.
7. Fittings.
8. Reinforcement and spacing.
9. Seam and joint construction.
10. Penetrations through fire-rated and other partitions.
11. Equipment installation based on equipment being used on Project.
12. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

C. Coordination Drawings: Provide coordination drawings for all medium pressure duct runs from main air handler units due to limited and congested ceiling spaces. Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.

D. Quality Control Reports (QCR):

1. Welding Qualifications: Qualify procedures and personnel according to the following:

a. AWS D1.1 "Structural Welding Code - Steel," for hangers and supports.
b. AWS D1.2 "Structural Welding Code - Aluminum," for aluminum supports.
c. AWS D9.1 "Sheet Metal Welding Code," for duct joint and seam welding.

1.3 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thickness, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.2 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."

2.3 ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

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

    a. McGill AirFlow LLC
    b. SEMCO, LLC; part of FlaktGroup
    c. Sheet Metal Connectors, Inc.
    d. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653.

1. Galvanized Coating Designation: G60.

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

A. Provide hangers and supports as specified in Section 230529.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Install fire dampers where ducts pass through fire-rated interior partitions and exterior walls. Comply with requirements in Section 233300 for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCTWORK EXPOSED TO WEATHER

A. All external joints are to be welded or have secure watertight mechanical connections. Seal all openings to provide weatherproof construction.

B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.

C. If outer surface of duct is uninsulated, protect outer surface with suitable paint. Paint materials and application requirements are specified in Section 099000 "Painting and Coating."

3.4 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.5 HANGER AND SUPPORT INSTALLATION

A. Install hangers and supports as specified in Section 230529.

3.6 DUCTWORK INSULATION

A. Provide and install duct insulation as specified in Section 230700.

3.7 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.8 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing. Clean existing ductwork in locations where contractor introduced dirt and/or dust into the system.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

3.9 START UP

A. Air Balance: Comply with requirements in Section 230593.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
b. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
c. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
d. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
e. Outdoor-Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
5. Test for leaks before applying external insulation.
6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
7. Give seven days' advance notice to CAWCD for testing.

3.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, and Heat Pumps:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: C.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 8.

2. Ducts Connected to Variable Volume Air-Handling Units:

a. Pressure Class: Positive 4-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round and Flat Oval: 2.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units and Heat Pumps:

a. Pressure Class: negative 2-inch wg.
b. Minimum SMACNA Seal Class: C.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 8.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 8.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting Air:

    a. Pressure Class: Negative 2-inch wg.
    b. Minimum SMACNA Seal Class: A
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 8.

2. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.

    a. Exposed to View: Type 304, stainless steel sheet, No. 4 finish.
    b. Concealed: Carbon-steel sheet.
    c. Welded seams and joints.
    d. Pressure Class: Positive or negative 4-inch wg.
    e. Airtight/watertight.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

    a. Velocity 1000 fpm or Lower:

        1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
        2) Mitered Type RE 4 without vanes.

    b. Velocity 1000 to 1500 fpm:

        1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
        2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
        3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

    c. Velocity 1500 fpm or Higher:

        1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
        2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
        3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

    a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

    a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

        1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
        2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
        3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
        4) Radius-to Diameter Ratio: 1.5.

    b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
    c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

    a. Rectangular Main to Rectangular Branch: 45-degree entry.
    b. Rectangular Main to Round Branch: Spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

    a. Velocity 1000 fpm or Lower: 90-degree tap.
    b. Velocity 1000 to 1500 fpm: Conical tap.
    c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers
2. Manual volume dampers
3. Control dampers
4. Fire dampers
5. Smoke dampers
6. Flange connectors
7. Turning vanes
8. Duct-mounted access doors
9. Flexible connectors
10. Flexible ducts
11. Duct accessory hardware

1.2 ACTION SUBMITTALS

A. Product Data (PD): Submit manufacturers catalog information for each type of product.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work. With prior approval from CAWCD, this submittal can be combined with submittal requirements from Section 233113 if information is combined with that submittal.

1. Detail fabrication of duct accessories and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances, and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings
b. Manual volume damper installations
c. Control-damper installations
d. Fire-damper and smoke-damper installations, including sleeves and duct-mounted access doors
e. Wiring Diagrams: For power, signal, and control wiring

C. Operation and maintenance data shall be included in final O&M Manuals provided to CAWCD.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653.

1. Galvanized Coating Designation: G90
2. Exposed-Surface Finish: Mill phosphatized

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

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

1. Greenheck Fan Corporation.
2. Pottorff
3. Ruskin

B. Description: Gravity balanced

C. Performance:

1. Maximum Air Velocity: 1000 fpm
2. Maximum System Pressure: 1-inch wg

D. Construction:

1. Frame: Hat-shaped, 0.05-inch- thick, galvanized sheet steel, with welded corners or mechanically attached mounting flange
2. Blades: Multiple single-piece blades, center pivoted maximum 6-inch (150-mm) width, with sealed edges
3. Blade Action: Parallel

E. Blade Seals: Neoprene, mechanically locked

F. Blade Axles:

1. Material: Galvanized steel

2. Diameter: 0.20 inch

G. Tie Bars and Brackets: Galvanized steel

H. Return Spring: Adjustable tension

I. Bearings: Steel ball

J. Accessories:

1. Adjustment device to permit setting for varying differential static pressure
2. Counterweights and spring-assist kits for vertical airflow installations
3. Electric actuators
4. Chain pulls
5. Screen Mounting: Front mounted in sleeve

a. Sleeve Thickness: 20 gage minimum
b. Sleeve Length: 6 inches minimum

6. Screen Mounting: Rear mounted
7. Screen Material: Galvanized steel
8. Screen Type: Bird
9. 90-degree stops

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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

a. Greenheck Fan Corporation
b. McGill Airflow LLC
c. Pottorff
d. Ruskin
e. Trox USA Inc.
f. Vent Products Co., Inc

2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.
4. Frames:

a. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel
b. Mitered and welded corners
c. Flanges for attaching to walls and flangeless frames for installing in ducts

5. Blades:

a. Multiple or single blade
b. Parallel- or opposed-blade design
c. Stiffen damper blades for stability

d. Galvanized steel, 0.064 inch thick

6. Blade Axles: Galvanized steel
7. Bearings:

a. Stainless-steel sleeve
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel

B. Jackshaft:

1. Size: 0.5-inch diameter
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.5 CONTROL DAMPERS

A. Manufacturers: Control dampers integrated into the BMS system are to be pre-approved by Controls Contractor prior to submitting to CAWCD for approval. Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. McGill Airflow LLC
3. Pottorff
4. Ruskin

2.6 Construction:

A. Linkage out of airstream.

B. Standard leakage rating.

C. Suitable for horizontal or vertical airflow applications.

D. Frames:
1. U-shaped.
2. 0.094-inch- thick, galvanized sheet steel.
3. Mitered and welded corners.

E. Blades:

1. Multiple blades with maximum blade width of 6 inches
2. Parallel and opposed-blade design
3. Galvanized steel
4. 0.064-inch-thick single skin
5. Blade Edging: Closed-cell neoprene
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals

F. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F

G. Bearings:

1. Stainless-steel sleeve.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade

2.7 FIRE DAMPERS

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

1. Greenheck Fan Corporation
2. Pottorff
3. Ruskin

B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: Shall match or exceed rating of wall.

E. Frame: Type B curtain type with blades outside airstream.

F. Mounting Sleeve: Factory or field-installed, galvanized sheet steel

1. Minimum Thickness: 0.138 inch thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, galvanized sheet steel. In place of interlocking blades, use full-length, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Fusible link, factory installed, 165 deg F rated.

2.8 SMOKE DAMPERS

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

1. Greenheck Fan Corporation
2. Pottorff
3. Ruskin

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Construction:

1. Frame: Hat-shaped, galvanized sheet steel, with welded corners and mounting flange.
2. Blades: Roll-formed, horizontal, galvanized sheet steel.
3. Leakage: Class I.
4. Rated pressure and velocity to exceed design airflow conditions.
5. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

E. Damper Motors: two position action.

F. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230900.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Electrical Connection: 115 V, single phase, 60 Hz.

G. Accessories:

1. Auxiliary switches for position indication.
2. Test and reset switches, damper mounted.

2.9 FLANGE CONNECTORS

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

1. Ductmate Industries, Inc; a DMI company
2. Elgen Manufacturing

B. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.10 TURNING VANES

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

1. Ductmate Industries, Inc; a DMI company
2. Duro Dyne Inc.
3. Elgen Manufacturing
4. METALAIRE, Inc.
5. SEMCO Incorporated.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. 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.

D. 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."

E. Vane Construction: Double wall.

2.11 DUCT-MOUNTED ACCESS DOORS

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

1. Ductmate Industries, Inc; a DMI company
2. Elgen Manufacturing.
3. Greenheck Fan Corporation
4. McGill AirFlow LLC
5. Pottorff

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel
d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.12 DUCT ACCESS PANEL ASSEMBLIES

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

1. Ductmate Industries, Inc; a DMI company
2. Flame Gard, Inc.
3. 3M

B. Labeled according to NFPA 96 and UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel

D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F

F. Minimum Pressure Rating: 10-inch wg, positive or negative

2.13 FLEXIBLE CONNECTORS

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

1. Ductmate Industries, Inc; a DMI company
2. Duro Dyne Inc.
3. Elgen Manufacturing.

4. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.14 FLEXIBLE DUCTS

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

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC
3. Thermaflex; a Flex-Tek Group Company

B. 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 film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.15 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils
2. Upstream from duct filters
3. At drain pans and seals
4. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment
5. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
6. At each change in direction and at maximum 50-foot spacing.
7. Upstream and downstream from turning vanes.
8. Control devices requiring inspection.
9. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.

5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

K. Label access doors according to Section 220553 to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. Connect diffusers to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

N. Connect flexible ducts to metal ducts with draw bands.

O. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that size and location of access doors are adequate to perform required operations.
3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

SECTION 233400 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Centrifugal fans.
2. Axial fans.
3. Propeller fans.
4. Downblast centrifugal roof fans.
5. Upblast centrifugal roof fans.
6. Centrifugal wall fans.
7. Ceiling fans.
8. Inline ceiling fans.
9. Duct blowers or cabinet fans.
10. Centrifugal square inline fans.
11. Upblast propeller roof fans.
12. Centrifugal filtered supply fans.
13. Combination kitchen hood supply and exhaust fans.
14. Roof ventilators.
15. Energy recovery ventilator.
16. Fan Array fans.

1.2 PERFORMANCE REQUIREMENTS

A. Wind-Borne Debris Loads: Design louvers located within 30 feet of grade to withstand ASTM E1996; large missile impact test.

1.3 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics, and connection requirements.
2. Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.
3. Manufacturer’s Certificate: Certify products meet or exceed specified requirements.
4. Product data to be reviewed and approved by Controls Contractor prior to submitting to CAWCD to ensure all controls components have been coordinated with Controls Contractor and there are no conflicts in product data prior to CAWCD review.

B. Shop Drawings (SD):

1. Indicate size and configuration of fan assembly, mountings, weights, ductwork, and accessory connections.

1.4 CLOSEOUT SUBMITTALS (CS)

A. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams. Include O&M data in final O&M Manuals submitted to CAWCD.

1.5 QUALITY ASSURANCE

A. Performance Ratings: Conform to ANSI/AMCA 210 and 300. Fans must be tested in accordance with AMCA Publications 211 and 311 in an AMCA accredited laboratory and certified for air and sound performance. Fans shall be licensed to bear the AMCA ratings seal for air performance (AMCA 210).

B. Sound Ratings: AMCA 301, tested to AMCA 300 and bear AMCA Certified Sound Rating Seal.

C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

D. Balance Quality: Conform to AMCA 204.

E. Fans shall have a Fan Energy Index (FEI) rating that meets or exceeds requirements of the latest edition of ASHRAE 90.1.

F. Fans shall be licensed to bear the Air Movement and Control Association (AMCA) Certified Ratings Program (CRP) seal for FEI.

G. The Fan FEI rating shall be indicated on the design documents and manufacturer product submittals to allow for compliance verification by the building official.

H. Classification for Spark Resistant Construction shall conform to ANSI/AMCA Standard 99.

I. Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3)

J. Comply with the National Electrical Manufacturers Association (NEMA) standards for motor and electrical accessories.

K. Each fan shall undergo a factory run test where fan RPM and amp draw are recorded. This information is available to the customer free of charge upon request.

1.6 QUALIFICATIONS

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

B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect motors, shafts, and bearings from weather and construction dust.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 EXTRA MATERIALS

A. Furnish two sets of belts for each belt-driven fan.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL FANS

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation
3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Performance:

1. Altitude: Per install site location.
2. Temperature Limit: Maximum 300 degrees F.
3. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

C. Wheel and Inlet:

1. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, back plate, backward curved blades welded or riveted to flange and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.
2. Forward Curved: Steel or aluminum construction with smooth curved inlet flange, back plate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and back plate; steel hub swaged to back plate and keyed to shaft with set screw.
3. Airfoil Wheel: Steel construction with smooth curved inlet flange, back plate die formed hollow airfoil shaped blades continuously welded at tip flange, and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.
4. Radial: Steel construction with inlet flange, reinforced back plate, plate blades welded or riveted to back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.
5. Fan Wheel shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19.

D. Housing:

1. Steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, braced, designed to minimize turbulence with spun inlet bell and shaped cut-off.
2. Factory finish before assembly to manufacturer's standard. For fans handling air downstream of humidifiers, fabricate of galvanized steel.
3. Bolted construction with horizontal flanged split housing, where indicated.
4. Fabricate plug fans without volute housing, in lined steel cabinet.

E. Bearings and Sleeve

1. Bearings: Pillow block type, self-aligning, grease lubricated.
2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.
3. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, 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 sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.
4. Belt Guard: Fabricate to SMACNA Standard; 0.106 inch thick, 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 with guard in place.

F. Accessories:

1. Fixed Inlet Vanes: Steel construction with fixed cantilevered inlet guide vanes welded to inlet bell.
2. Discharge Dampers: Opposed blade steel damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever.
3. Inlet/Outlet Screens: Galvanized steel welded grid.
4. Access Doors: Shaped to conform to scroll, with quick opening latches and gaskets.
5. Scroll Drain: 1/2-inch steel pipe coupling welded to low point of fan scroll.
6. Disconnect Switch: Factory mounted disconnect switch in control panel or on equipment.

2.2 AXIAL FANS

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation
3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Product Requirements:

1. Altitude: 1500 ft above sea level
2. Temperature Limit: Maximum 300 degrees F.

C. Hub and Impeller:

1. Airfoil Impeller Blades: Adjustable die cast aluminum alloy or welded steel die formed blades with belt drive.
2. Hub: Die cast aluminum alloy or cast iron hub or with belt drive of spun, welded steel, bored and keyed to shaft; to facilitate indexing of blade angle with adjustment stops.
3. Cast Components: Statically and dynamically balance assembly before attachment to motor or shaft.

D. Casing:

1. Fan housing shall be constructed of continuously welded steel and include an integral punched inlet and outlet flange to prevent air leakage.
2. Continuously weld, with inlet and outlet flange connections, and motor or shaft supports. Incorporate flow straightening guide vanes for fans specified for static pressures greater than 2 inches wg.
3. After fabrication all carbon steel components shall be cleaned and chemically treated by a phosphatizing process to insure proper removal of grease, oil, scale, etc. Fan shall then be coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be RAL 7023, concrete grey. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.
4. Belts, bearings, and drives shall be protected from the airstream by heavy gauge steel belt tubes bolted bearing covers.
5. Either an OSHA compliant weather hood, or an OSHA compliant belt guard shall be included to completely cover the motor pulley and belt(s).

E. Bearings and Drives:

1. Fan shaft bearings shall be Air Handling Quality, bearings shall be heavy-duty grease lubricated, self-aligning or roller pillow block type.
2. Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to ensure the inner race diameter is within tolerance to prevent vibration.
3. Bearings shall be selected for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each pressure class {Average Life or (L-50) of 400,000 hours} for horizontal mount and a basic rating fatigue life L(10) of 40,000 hours at maximum operating speed {Average Life or (L-50) of 200,000 hours} for vertical mount.
4. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed.
5. Bearings shall have Zerk fittings to allow for lubrication.
6. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil.

7. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, 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 sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.
8. Belt Guard: Fabricate to SMACNA Standards; 0.106 inch thick, 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 with guard in place.
9. Lubrication: Extend lubrication fittings to outside of casing.

F. Accessories:

1. Guide Vanes: Welded steel construction with airfoil vanes and casing flanges, finished to match casing.
2. Inlet Bell: Bell mouth inlet fabricated of steel or aluminum with flange.
3. Outlet Cones: Fabricated of steel with flanges, outlet area/inlet area ratio of 1.5/1.0, with center pod as recommended by manufacturer.
4. Inlet Screens: Galvanized steel welded grid to fit inlet bell.
5. Dampers: Welded steel construction, consisting of two semi-circular vanes pivoted on oil-retaining bearings in short casing section, finished with one coat enamel.
6. Access Doors: Shaped to conform to casing with quick opening latches and gaskets.
7. Stall Alarm Probe: Factory installed sensing probe to detect fan operation in stall.
8. Vibration Detector: Factory installed vibration switch to stop fan with extra set of contacts.
9. Disconnect Switch: Factory mount disconnect switch in control panel or on equipment.

2.3 PROPELLER FANS

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation
3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Construction:

1. Propeller: Cast aluminum propeller constructed of cast aluminum tapered airfoil blades and cast aluminum hub or Fabricated steel propeller constructed of galvanized steel blades and spider, attached to cast aluminum hub.
2. Statically and dynamically balanced in accordance with AMCA Standard 204-05.
3. Mounting arrangement options: Flush Interior and Flush Exterior.
4. Constructed of galvanized steel or painted steel with heavy gauge mounting flanges and pre-punched mounting holes.

C. Accessories:

1. Back-draft Damper: Multiple blade with offset hinge pin, blades linked.

2. Outlet Damper: Multiple blade with offset hinge pin, blades linked, line voltage motor drive, power open, spring return.
3. Safety Screens: Expanded galvanized metal over inlet, motor, and drive and outlet; to comply with OSHA regulations.
4. Hood: Weather shield, to exclude rain and snow.
5. Fan speed controller.
6. Disconnect Switch: Factory mount disconnect switch in control panel or on equipment.

2.4 DOWNBLAST CENTRIFUGAL ROOF FANS

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation
3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Fan Unit: Downblast type. V-belt or direct drive, with spun aluminum or galvanized steel with baked-on enamel housing; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Motor: Totally enclosed fan cooled, Class 1, Group D, explosion proof NEMA MG1.

E. Roof Curb: 12 inch high self-flashing of galvanized steel construction with continuously welded seams, built-in cant strips, 1 inch insulation and curb bottom, interior baffle with acoustic insulation, and factory installed nailer strip.

F. Disconnect Switch: Factory wired, non-fusible, in fan housing for thermal overload protected motor, NEMA 250 Type 3R enclosure.

G. Accessories:

1. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
2. Motor Operated Damper: Aluminum multiple blade construction felt edged with offset hinge pin, nylon bearings, blades linked and line voltage motor drive, power open, spring return.
3. Fan speed controller.

2.5 UPBLAST CENTRIFUGAL ROOF FANS

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation

3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Fan Unit: Upblast type. V-belt or direct drive spun aluminum housing with grease tray; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Motor: Totally enclosed fan cooled Class 1, Group D, explosion proof NEMA MG1.

E. Roof Curb: 16-inch-high self-flashing of galvanized steel construction with continuously welded seams, built-in cant strips, interior baffle with acoustic insulation, curb bottom, ventilated double wall, hinged curb adapter, and factory installed nailer strip.

F. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 3R enclosure.

G. Accessories:

1. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked and line voltage motor drive, power open, spring return.
2. Motor Operated Damper: Aluminum multiple blade construction felt edged with offset hinge pin, nylon bearings, blades linked and line voltage motor drive, power open, spring return.
3. Fan speed controller.

2.6 CENTRIFUGAL WALL FANS

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation
3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Fan Unit: V-belt or direct drive with spun aluminum housing; resiliently mounted motor; aluminum wire bird screen.

C. Sheaves: For V-belt drives, provide cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Motor: Totally enclosed fan cooled Class 1, Group D, explosion proof NEMA MG1.

E. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 3R enclosure.

F. Accessories:

1. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked and line voltage motor drive, power open, spring return.
2. Motor Operated Damper: Aluminum multiple blade construction felt edged with offset hinge pin, nylon bearings, blades linked and line voltage motor drive, power open, spring return.
3. Fan speed controller.

2.7 CEILING FANS

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation
3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Centrifugal Fan Unit: Direct driven with galvanized steel housing, resilient mounted motor, gravity backdraft damper in discharge opening, integral outlet duct collar. Discharge position convertible by moving interchangeable panels.

C. Disconnect Switch: Fan mounted toggle switch for thermal overload protected motor.

D. Grille: Molded white plastic.

E. Wheel: Centrifugal forward curved type constructed of injection molded or polypropylene resin.

F. Motor: Open drip proof type with permanently lubricated sealed bearings and thermal overload protection.

G. Accessories:

1. Wall cap with damper, round duct inlet.
2. Wall cap with rectangular duct inlet.
3. Eave elbow.
4. Roof jack constructed of corrosion resistant, galvanized steel with baked enamel finish.
5. Roof cap with roof curb.
6. Filter box.
7. Brick vent constructed of extruded aluminum with inlet screen.
8. Rubber-in-shear vibration isolator.
9. Ceiling radiation damper.
10. Fan speed controller.
11. Time delay relay.

2.8 INLINE CEILING FANS

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation
3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Configuration: Inline.

C. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with 1/2-inch acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge opening, integral inlet and outlet duct collar.

D. Disconnect Switch: Fan mounted toggle switch for thermal overload protected motor.

E. Wheel: Centrifugal forward curved type constructed of injection molded or polypropylene resin.

F. Motor: Open drip proof type with permanently lubricated sealed bearings and thermal overload protection, mounted on rubber-shear isolators.

2.9 DUCT BLOWER OR CABINET FANS

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation
3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Product Description: V-belt drive with galvanized steel housing, removable side panel for access, inlet and outlet duct collar, gravity backdraft damper in discharge, horizontal hanging brackets.

C. Fan Wheel: Double width-double inlet backward inclined or forward curved centrifugal type.

D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

E. Motor and Drive Mounting: Out of air stream.

F. Motor: Open drip proof or totally enclosed fan cooled as scheduled; two speed and/or explosion proof as scheduled, mounted on vibration isolators. NEMA MG1.

G. Bearings: ABMA 9 life at 200,000 hours.

H. Accessories:

1. Belt guard.
2. Disconnect Switch: NEMA 250 Type 1 enclosure.
3. Slide out filter box with permanent type filter.

2.10 CENTRIFUGAL SQUARE INLINE FANS

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation
3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Product Description: V-belt or direct drive as scheduled with galvanized steel housing, integral inlet cone, inlet and outlet duct collar, gravity backdraft damper in discharge, horizontal hanging brackets.

C. Fan Wheel: Non-overloading, mixed flow, aluminum construction.

D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

E. Motor and Drive Mounting: Out of air stream.

F. Motor: Open drip proof, NEMA MG1.

G. Bearings: ABMA 9 life at 200,000 hours.

H. Accessories:

1. Belt guard.
2. Motor cover.
3. Inlet safety screen.
4. Outlet safety screen.
5. Flexible duct connector.
6. Filter box with permanent type filter.
7. Flanged inlet and outlet.
8. Inlet and Outlet ductwork companion flange.
9. Disconnect Switch: NEMA 250 Type 1 enclosure.
10. Fan speed controller.

2.11 UPBLAST PROPELLER ROOF FANS

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation
3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Fan Unit: V-belt or direct drive, with aluminum or galvanized steel with baked-on enamel housing; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets. Butterfly type gravity dampers mounted in discharge air stream.

C. Blades: Shaped steel or aluminum air foil blades with heavy hubs, statically and dynamically balanced, keyed and locked to shaft, directly connected to shaft.

D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

E. Motor: Totally enclosed fan cooled Class 1, Group D, explosion proof NEMA MG1.

F. Roof Curb: 12-inch-high self-flashing of galvanized steel construction with continuously welded seams, built-in cant strips, interior baffle with acoustic insulation, curb bottom, hinged curb adapter, and factory installed nailer strip.

G. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 3R enclosure.

2.12 CENTRIFUGAL FILTERED SUPPLY FAN

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation
3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Hood: Square configuration, constructed of bolted, galvanized steel housing; insulated top cover, bottom skirt for attachment to roof curb, aluminum wire bird screen.

C. Fan Unit: Direct drive, mixed flow or backward inclined, centrifugal blower with vibration isolator or resilient mounted motor.

D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

E. Motor: Open drip proof for indoor applications and totally enclosed fan cooled for outdoor applications.

F. Filter: 1-inch-thick aluminum media, washable and cleanable.

G. Roof Curb: 12-inch-high self-flashing of galvanized steel construction with continuously welded seams, built-in cant strips, 1 inch insulation and curb bottom, interior baffle with acoustic insulation, curb bottom, hinged curb adapter, and factory installed nailer strip.

H. Accessories:

1. Gravity operated backdraft damper with spring return.
2. Motorized intake backdraft damper.
3. Disconnect Switch: NEMA 250 Type 3R enclosure.
4. Airflow proving contact.

2.13 GRAVITY ROOF VENTILATORS

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation
3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Product Description: Square or round type, with aluminum or galvanized steel with baked-on enamel housing; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.

C. Roof Curb: 12-inch-high self-flashing of galvanized steel construction with continuously welded seams, built-in cant strips, 1 inch insulation and curb bottom, interior baffle with acoustic insulation, curb bottom, and factory installed nailer strip.

D. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.

E. Motor Operated Damper: Aluminum multiple blade construction felt edged with offset hinge pin, nylon bearings, blades linked and line voltage motor drive, power open, spring return.

2.14 ENERGY RECOVERY VENTILATOR

A. Manufacturers:

1. Loren Cook Company
2. Greenheck Fan Corporation
3. ACME Engineering & Manufacturing Corp.
4. Or as approved by CAWCD

B. Unit Casing: Constructed of galvanized steel with bolted construction using corrosion resistant fasteners. Furnish with inlet and outlet duct collars. Top side and interior panels insulated with 1” thick glass fiber insulation. Side panels hinged and removable for access to internal components. Energy wheel mounted in sliding tack for access and cleaning. Fans and motor assembly mounted in sliding track for access.

C. Energy Wheel: The wheel media shall be a polymer film matrix in a stainless-steel framework and be comprised of individual segments that are removable for servicing. Non-segmented energy wheels are not acceptable. Silica gel desiccant shall be permanently bonded to the polymer film and shall be designed and constructed to permit cleaning and servicing. The energy wheel is to have a five-year warranty. Performance criteria are to be as specified in AHRI Standard 1060, complying with the Combined Efficiency data in the submittal.

D. Fans: Individual supply and exhaust fans. Direct drive, single width, single inlet, forward curved, centrifugal blower with resilient mounted motor.

E. Motors: Totally enclosed fan cooled with permanently lubricated sealed type bearings with ABMA 9 life at 200,000 hours.

F. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position.

G. Filter: 2 inch thick 30 percent efficient pleated type located in both supply and exhaust air streams.

H. Electrical: Components factory wired for single point power connection. Control panel UL listed with access door.

I. Roof Curb: 12-inch-high self-flashing of galvanized steel construction with continuously welded seams, built-in cant strips, 1 inch insulation and curb bottom, and factory installed nailer strip.

J. Accessories:

1. Duct adapter for vertical discharge configuration.
2. Intake weather hood with 2-inch washable aluminum filters.
3. Exhaust weather hood with bird screen.
4. Gravity operated dampers factory installed in supply and exhaust air streams.
5. Disconnect Switch: NEMA 250 Type 3R enclosure.
6. Spring or rubber-in-shear type vibration isolators.
7. Fan speed controller.

K. Controls: Furnish unit with the following:

1. Dirty Filter Sensor: Activates warning light.
2. Rotation Sensor: Sends signal to remote indicator when wheel stops.
3. Economizer Mode: Stops wheel operation when outside air conditions approximate indoor air conditions. Furnish with enthalpy sensors.
4. Frost Control: Unit on-off operation.

2.15 FAN ARRAY FANS

A. Manufacturers:

1. Nortek Air Solutions
2. Temtrol
3. Loren Cook Company
4. Greenheck Fan Corporation
5. Energy Labs.
6. Or as approved by CAWCD

B. Fan, Drive, and Motor Section

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

a. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.

1) Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
2) Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
3) The fan wheel shall be direct coupled to the motor shaft.

2. The unit fan section shall have interior wall and roof panels perforated with 3/32 holes on 5/32 staggered centers. Where perforated panels are used, the 2 inch thick 3 lb. density acoustic insulation shall be encased in mylar. Air stream side of the insulation with the mylar tracing shall withstand air velocities up to 4000 FPM without delaminating or erosion. Insulation shall comply with flame spread rating of less than 25 and smoke developed rating of less than 50, per ASTM E 84. The insulation shall have the following sound attenuation characteristics:

OCTAVE BANDS	125	250	500	1k	2K	4K	NCR
Absorption Coefficient	2.8	2.9	2.10	2.11	2.12	2.13	2.14

a. Single width, single inlet, class II, direct-drive type plenum fan dynamically balanced as an assembly, as shown in schedule. Maximum fan RPM shall be below first critical fan speed. Fan assemblies shall be dynamically balanced by the manufacturer on all three planes.
b. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.
c. Airfoil Fan Wheels: Steel construction with curved inlet flange, backplate, airfoil blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft.
d. Fan Array

1) The multiple fan array systems shall include multiple, direct driven, arrangement 6 plenum fans constructed per AMCA requirements for the duty specified class III as required. Class I fans are not acceptable. Fans shall be rated in accordance with and certified by AMCA for performance. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan’s peak static pressure producing capability at the specified fan/motor speed. Each fan/motor cube or cell shall include a minimum 10-gauge, G 90 Galvanized steel intake wall, .100 aluminum spun fan inlet funnel, and a 10-gauge G90 Galvanized steel motor support plate rail and structure. All motors shall be standard foot mounted type TEAO selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2. Motors shall be manufactured for use in multiple fan arrays that operate at varying synchronous speeds as driven by an approved VFD. Motor HP shall not exceed the scheduled HP as indicated in the AHU equipment schedule(s). Steel cased motors and/or ODP motors are not acceptable. All motors shall include permanently sealed (L10-300,000 hr) bearings and shaft grounding to protect the motor bearings from electrical discharge machining due to stray shaft

currents. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, exceeding category BV-5, to meet or exceed an equivalent Grade G.55, producing a maximum rotational imbalance of .022" per second peak, filter in. Fan and motor assemblies submitted for approval incorporating larger than 22" wheel size and 215 T frames size motors shall be balanced in three orthogonal planes to demonstrate compliance with the G.55 requirement with a maximum rotational imbalance of .022" per second peak filter in.

2) The fan array shall consist of multiple fan and motor "cubes" or "cells", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. In order to assure uniform velocity profile in the AHU cross section, the fan cube dimensions must be variable, such that each fan rests in an identically sized cube or cell, and in a spacing that must be such that the submitted array dimensions fill a minimum of 90% of the cross-sectional area of the AHU air way tunnel. There shall be no blank off plates or "spacers" between adjacent fan columns or rows to position the fans across the air way tunnel. The array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit to equal the specified cooling coil and/or filter bank face velocity by +/- 10% when measured at a point 36" from the intake side of the fan array intake plenum wall, and at a distance of 72" from the discharge side of the fan array intake plenum wall.
3) Each individual cube or cell in the multiple fan arrays shall be provided with an integral back flow prevention device that prohibits recirculation of air in the event a fan or multiple fans become disabled. The system effects for the back flow prevention device(s) shall be included in the criteria for TSP determination for fan selection purposes and shall be indicated as a separate line-item SP loss in the submittals. Back Draft Damper performance data that is per AMCA ducted inlet and discharge arrangements will not be accepted. Damper data must be for the specific purpose of preventing back flow in any disabled fan cube and that is mounted directly at the inlet of each fan. Motorized dampers for this purpose are not acceptable. Submitted fan performance data which only reflect published performance for individual fans in AMCA arrangement "A" free inlet and discharge will not be accepted. AHU Manufacturers that do not manufacture the fans being submitted on must provide certified performance data for fans as installed in the AHU unit with Back Draft damper effects included.
4) Each fan motor shall be individually wired to a control panel containing a redundant VFD package with manual motor protectors with a bypass, as specified elsewhere. VFD shall be sized for the total connected HP for all fan motors contained in the fan array. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards and local code requirements.
5) Each fan & motor assembly shall be removable through a 24" wide, free area, access door located on the discharge side of the fan wall array without removing the fan wheel from the motor. All fan/motor access doors shall open against pressure.
6) All motors in the fanwall Array shall be provided with individual Motor Protection for thermal overload protection. All motor circuit protectors can

be located in starting device enclosure or, if required by design, in a separate enclosure. Motor circuit protector enclosure must be located and mounted at a minimal distance from motors in the fanwall Array. Provide remote indication by means of aux contacts wired in series.

a) Remote indication: Current Sensors wired in series
b) Pilot lights: Multiple (one per fan) cover mounted pilot lights for local monitoring.

e. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 2 inches.
f. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513

1) Enclosure Type: Totally enclosed, fan cooled.
2) NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
3) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4) Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5) Mount unit-mounted disconnect switches on exterior of unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify roof curbs are installed and dimensions are as shown on shop drawings and as instructed by manufacturer.

3.2 INSTALLATION

A. Secure fans and gravity ventilators with cadmium plated steel lag screws to roof curb or structure.

B. Suspended Fans: Install flexible connections between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

C. Install backdraft dampers on inlet to exhaust fans and gravity ventilators used in relief air applications.

D. Provide backdraft dampers on outlet from cabinet and ceiling fans and as indicated on Drawings.

E. Install safety screen where inlet or outlet is exposed.

F. Pipe scroll drains to nearest floor drain.

G. Install backdraft dampers on discharge of exhaust fans and as indicated on Drawings.

H. Provide sheaves required for final air balance.

3.3 MANUFACTURER'S FIELD SERVICES

A. Furnish services of factory trained representative for minimum of one day to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.4 CLEANING

A. Vacuum clean coils and inside of fan cabinet.

3.5 DEMONSTRATION

A. Train CAWCD maintenance personnel to adjust, operate, and maintain fans. Notify CAWCD of time needed for training one month prior to incorporate into project schedule.

3.6 PROTECTION OF FINISHED WORK

A. Do not operate fans until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION 233400

SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ceiling diffusers - round face.
2. Ceiling diffusers - square face.
3. Diffusers - louver face.
4. Diffusers - linear bar.
5. Diffusers - ceiling-integral plenum slot.
6. Diffusers - ceiling-linear continuous slot.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, and noise ratings.
b. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Coordination Drawings (CD):

1. Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.

a. Ceiling suspension assembly members
b. Method of attaching hangers to building structure
c. Size and location of initial access modules for acoustical tile
d. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings
e. Duct access panels

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

1.4 QUALIFICATIONS

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

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Air diffusers shall be stored and handled in a safe and secure manner to prevent damage from equipment, traffic, theft, and vandalism.

B. Store indoors, protected from weather to prevent rust or corrosion.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS - ROUND FACE

A. Ceiling Diffuser - Round Face:

1. Manufacturers:

    a. Price Industries Limited
    b. Titus
    c. Krueger-HVAC
    d. Or CAWCD Approved Equal

2. Description: Round ceiling diffuser with duct collar and a series of conical curved blades to provide discharge parallel to ceiling surface.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material: Steel or Aluminum.
5. Finish: Baked enamel, white or Anodized aluminum.
6. Face Style: Cone.
7. Mounting: Duct.
8. Pattern: Adjustable.
9. Dampers: Radial opposed blade.
10. Accessories:

    a. Equalizing grid.
    b. Plaster ring.
    c. Safety chain.
    d. Wire guard.
    e. Sectorizing baffles.
    f. Manual remote balancing damper operator.
    g. UL 555C fire-rated assembly, including fire damper and insulating blanket where indicated on Project Drawings.

2.2 CEILING DIFFUSERS - SQUARE FACE

A. Ceiling Diffuser - Square:

1. Manufacturers:

a. Price Industries Limited
b. Titus
c. Krueger-HVAC
d. Or CAWCD Approved Equal

2. Description: Square ceiling diffuser with round or rectangular duct collar and a series of curved louvers to provide discharge parallel to ceiling surface.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material: Steel or Aluminum.
5. Finish: Baked enamel, white or Anodized aluminum.
6. Face Size: 24 by 24 inches for ceiling grids. Size as indicated on Project Drawings for Surface mount applications.
7. Face Style: Three cone.
8. Mounting: T-bar or surface mount where indicated on Project Drawings.
9. Pattern: Fixed.
10. Dampers: Radial opposed blade.
11. Accessories:

a. Equalizing grid.
b. Plaster ring.
c. Safety chain.
d. Wire guard.
e. Sectorizing baffles.
f. Manual remote balancing damper operator.
g. UL 5555C fire-rated assembly, including fire damper and insulating blanket where indicated on Project Drawings.

2.3 DIFFUSERS - LOUVER FACE

A. Diffuser - Louver Face:

1. Manufacturers:

a. Price Industries Limited
b. Titus
c. Krueger-HVAC
d. Or CAWCD Approved Equal

2. Description: Square diffuser with outer border, duct collar, and curved face louvers to direct air discharge in one, two, three, or four directions, parallel to ceiling surface.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material: Steel or Aluminum.
5. Finish: Baked enamel, white or Anodized aluminum.
6. Face Size: As indicated on Project Drawings.
7. Mounting: T-bar or surface mount where indicated on Project Drawings.
8. Pattern: Four-way unless indicated otherwise on Project Drawings.
9. Dampers: Radial opposed blade.
10. Accessories:

a. Square to round neck adaptor.

b. Adjustable pattern vanes.
c. Throw reducing vanes.
d. Equalizing grid.
e. Plaster ring.
f. Safety chain.
g. Wire guard.
h. Sectorizing baffles.
i. Manual remote balancing damper operator.
j. UL 5555C fire-rated assembly, including fire damper and insulating blanket where indicated on Project Drawings.

2.4 DIFFUSERS - LINEAR BAR

A. Diffuser - Linear Bar:

1. Manufacturers:

   a. Price Industries Limited
   b. Titus
   c. Krueger-HVAC
   d. Or CAWCD Approved Equal

2. Description: Frame with multiple fixed or adjustable vanes or blades to deflect supply air direction. Frame width and length are as indicated on Project Drawings.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material: Steel or Aluminum.
5. Finish: Baked enamel, white.
6. Wide Core Spacing Arrangement:

   a. 3/16-inch- thick blades spaced 1/2 inch apart; zero-degree deflection.

7. Deflection Vanes:

   a. Two-Way Deflection Vanes: Extruded construction; fixed louvers with removable core.

8. Frame: 1 inch wide.
9. Mounting: Countersunk screw, Concealed bracket, or Spring clip.
10. Damper Type: Adjustable opposed-blade assembly.
11. Provide plaster frame, directional vanes, alignment pins, core clips, and/or blank-off strips as required to render a complete installation.

2.5 DIFFUSERS - CEILING-INTEGRAL PLENUM SLOT

A. Diffuser - Ceiling-Integral Plenum Slot:

1. Manufacturers:

   a. Price Industries Limited
   b. Titus
   c. Krueger-HVAC

d. Or CAWCD Approved Equal

2. Description: Diffuser assembly with integral pattern controller, one or more linear discharge slots, and an integral plenum and duct collar. Assembly is to be installed in modular T-bar ceilings.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material:

    a. Face: Steel or Aluminum.
    b. Pattern Controller and Tees: Aluminum.
    c. Plenum: Steel, internally insulated.
    d. Plenum Insulation: Comply with UL 181.

5. Finish:

    a. Face and Plenum: Baked enamel.
    b. Pattern Controller: Baked enamel, black.
    c. Tees: Baked enamel, white.

6. Slot Width: 3/4 inch.
7. Number of Slots: As indicated on Project Drawings.
8. Length: As indicated on Project Drawings.
9. Accessories: Plaster frame or T-bar slot.
10. Fire-Rated Construction: Where indicated on Project Drawings, provide integral fire damper and fire-rated assembly listing in the Underwriters Laboratory Fire Resistance Directory, tested in accordance with UL 263 and complying with NFPA 90A requirements.

2.6 DIFFUSERS - CEILING-LINEAR CONTINUOUS SLOT

A. Diffuser - Ceiling-Linear Continuous Slot:

1. Manufacturers:

    a. Price Industries Limited
    b. Titus
    c. Krueger-HVAC
    d. Or CAWCD Approved Equal

2. Description: Linear diffuser assembly with continuous slots; adjustable vane in each slot to direct airflow in required direction.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Slot Width: 1 inch.
5. Section Length: As indicated on Project Drawings.
6. Straight and curved sections as required to accommodate layout.
7. Mitered tees and corners.
8. Pattern control vanes.
9. Material: Aluminum, extruded, heavy wall.
10. Finishes:

    a. Exterior: Standard white.

b. Interior: Standard black.

11. Throw: As indicated on Project Drawings.
12. Mounting: As indicated on Project Drawings.
13. Plenum Insulation: Comply with UL 181.
14. Other Features:

    a. Blank-offs.

2.7 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers in accordance with ASHRAE 70.

PART 3 - EXECUTION

3.1 INSTALLATION OF AIR DIFFUSERS

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13

SECTION 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Registers - adjustable-blade face.
2. Registers - fixed-blade face.
3. Grilles - adjustable-blade face.
4. Grilles - fixed-blade face.
5. Grilles - linear bar.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, and noise ratings.
b. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Coordination Drawings (CD):

1. Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.

a. Ceiling suspension assembly members
b. Method of attaching hangers to building structure
c. Size and location of initial access modules for acoustical tile
d. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings
e. Duct access panels

2. Provide shop drawings for registers and grilles greater than 8 SF and any custom fabricated registers or grilles

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

1.4 QUALIFICATIONS

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

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Registers and grilles shall be stored and handled in a safe and secure manner to prevent damage from equipment, traffic, theft, and vandalism.

B. Store indoors, protected from weather to prevent rust or corrosion.

PART 2 - PRODUCTS

2.1 REGISTERS

A. Registers - Adjustable-Blade Face:

1. Manufacturers:

a. Price Industries Limited
b. Titus
c. Krueger-HVAC
d. Or CAWCD Approved Equal

2. Material: Steel or Aluminum.
3. Finish: Baked enamel, white or Clear anodized.
4. Face-Blade Arrangement: Face blades with adjustable angle to permit manual adjustment of air discharge direction. Blades spaced 3/4 inch apart along long dimension.
5. Core Construction: Integral.

B. Registers - Fixed-Blade Face:

1. Manufacturers:

a. Price Industries Limited
b. Titus
c. Krueger-HVAC
d. Or CAWCD Approved Equal

2. Material: Steel or Aluminum.
3. Finish: Baked enamel, white or Clear anodized.
4. Face-Blade Arrangement: Fixed-position face blades, spaced 3/4 inch apart along long dimension.
5. Core Construction: Integral.
6. Frame: 1 inch wide.

2.2 GRILLES

A. Grilles - Adjustable-Blade Face:

1. Manufacturers:

    a. Price Industries Limited
    b. Titus
    c. Krueger-HVAC
    d. Or CAWCD Approved Equal

2. Material: Steel or Aluminum.
3. Finish: Baked enamel, white or Clear anodized.
4. Face-Blade Arrangement: Face blades with adjustable angle to permit manual adjustment of discharge direction. Blades spaced 3/4 inch apart along long dimension.
5. Core Construction: Integral.

B. Grilles - Fixed-Blade Face:

1. Manufacturers:

    a. Price Industries Limited
    b. Titus
    c. Krueger-HVAC
    d. Or CAWCD Approved Equal

2. Material: Steel or Aluminum.
3. Finish: Baked enamel, white.
4. Face-Blade Arrangement: Fixed-face blade position, blades spaced 3/4 inch apart along long dimension.
5. Core Construction: Integral.
6. Frame: 1 inch wide.
7. Mounting: Countersunk screw, Concealed, or Lay in.

C. Grilles - Linear Bar:

1. Manufacturers:

    a. Price Industries Limited
    b. Titus
    c. Krueger-HVAC
    d. Or CAWCD Approved Equal

2. Material Steel or Aluminum.
3. Finish: Baked enamel, white or Clear anodized.
4. Face-Blade Arrangement:

    a. Blade width: 1/4 inch
    b. Blade spacing; 1/2 inch.
    c. Fixed 15-degree discharge angle.

5. Core Construction: Integral.

6. Distribution plenum.

    a. Internal insulation.
    b. Inlet damper.

7. Frame: 1 inch wide.
8. Mounting: Countersunk screw, Concealed, or Lay in.
9. Damper Type: Adjustable opposed blade.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles in accordance with ASHRAE 70.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION OF REGISTERS AND GRILLES

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

SECTION 236400 - PACKAGED WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following items for reciprocating, scroll, and screw chillers:

1. Chiller package
2. Charge of refrigerant and oil
3. Controls and control connections
4. Chilled water connections
5. Condenser water connections
6. Refrigerant connections
7. Auxiliary water connections
8. Starters

1.2 DEFINITIONS

A. Coefficient of Performance (COP) - cooling: The ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.

B. Integrated Part-Load Value (IPLV): A single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment calculated per the method defined by AHRI 550/590 and referenced to AHRI standard conditions.

C. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and intended for operating conditions other than AHRI standard rating conditions.

D. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

E. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

1.3 ACTION SUBMITTALS

A. Product Data (PD):

1. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include startup instructions.
2. Manufacturer's Certificate: Certify products meet or exceed specified requirements including those furnished but not produced by manufacturer.
3. Submit rated capacities, weights, specialties and accessories, electrical requirements, wiring diagrams, and control diagrams.
4. Performance at AHRI standard conditions and at conditions indicated.

5. Performance at AHRI standard unloading conditions.
6. Minimum evaporator flow rate.
7. Refrigerant capacity of chiller.
8. Oil capacity of chiller.
9. Fluid capacity of evaporator.
10. Characteristics of safety relief valves.
11. Minimum entering condenser-air temperature.
12. Maximum entering condenser-air temperature.

B. Shop Drawings (SD):

1. Indicate components, assembly, dimensions, weights and loads, required clearances, and location and size of field connections. Indicate valves, strainers, and thermostatic valves required for complete system. Include wiring diagrams for power, signal, and control wiring.
2. Coordination Drawings: Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing. The following items shall be shown and coordinated with each other, using input from Installers of the items involved:

    a. Structural supports.
    b. Piping roughing-in requirements.
    c. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
    d. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

C. Closeout Submittals (G)

1. Operation and Maintenance Data: Submit start-up instructions, warranty, maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide. O&M Data to be included in final O&M Manuals provided to CAWCD at closeout.

D. Quality Control Reports (QCR)

1. Manufacturer's Field Reports: Submit start-up report for each unit. Indicate results of leak test and refrigerant pressure test.

1.4 QUALITY ASSURANCE

A. Conform to AHRI 550/590 code for testing and rating of chillers.

B. Performance Ratings: Coefficient of Performance (COP) and Integrated Part-Load Value (IPLV) not less than prescribed by ASHRAE 90.1.

C. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and include an ASME U-stamp and nameplate certifying compliance.

D. Comply with NFPA 70.

E. Comply with requirements of UL 1995 and include label by a qualified testing agency showing compliance.

F. Unit shall be manufactured in a facility registered to ISO 9001:2000 Manufacturing Quality Standard.

G. Unit shall be full load run tested at factory in an AHRI certified test facility.

1. The manufacturer shall supply a certified test report to confirm performance as specified. Proper AHRI certification documents for the test loop shall be made available upon request from the manufacturer for inspection. The performance test shall be conducted in accordance with AHRI Standard 550/590 procedures and tolerances.
2. The performance test shall be run with clean tubes in accordance with AHRI Standard 550/590- to include the following:
3. The factory test instrumentation shall be per AHRI Standard 550/590, and the calibration of all instrumentation shall be traceable to the National Institute of Standards and Technology (formerly NBS).
4. CAWCD shall be notified 14 days in advance to witness the factory performance test. If CAWCD desires to witness the performance test, all travel expenses will be CAWCD's responsibility.
5. A certified test report of all data shall be submitted to CAWCD prior to completion of the project. The factory certified test report shall be signed by an officer of the manufacturer's company. Preprinted certification will not be acceptable; certification shall be in the original.
6. The equipment will be accepted if the test procedures and results are in conformance with AHRI Standard 550/590. If the equipment fails to perform within allowable tolerances, the manufacturer will be allowed to make necessary revisions to their equipment and retest as required. The manufacturer shall assume all expenses incurred by CAWCD to witness the retest.
7. Equipment manufacturer shall not invoice for the chillers(s) until successful completion of the performance test.

H. ASHRAE 15 for safety code for mechanical refrigeration.

I. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with service facilities within 250 miles of Project.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum one month prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept chillers on site in factory packaging. Inspect for damage.

B. Protect indoor chillers from weather by storing under roof.

C. Manufacturer shall ship chillers from the factory fully charged with refrigerant.

D. hip each oil-lubricated chiller with a full factory installed charge of oil.

E. Unit controls shall be capable of withstanding 150 Deg F storage temperatures in the control compartment.

1.8 WARRANTY

A. Furnish five-year manufacturer warranty to include coverage for complete assembly including materials and labor. Warranty shall begin on date of start-up.

1.9 MAINTENANCE SERVICE

A. Refer to Section 017000 for requirements for maintenance service.

B. Examine unit components monthly. Clean, adjust, and lubricate equipment.

C. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

D. Perform work without removing units from service during building normal occupied hours. Coordinate all service work with CAWCD maintenance personnel.

E. Provide emergency call back service at all hours for this maintenance period.

F. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

G. Perform maintenance work using competent and qualified personnel under supervision and in direct employ of manufacturer or original installer.

H. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of CAWCD.

1.10 MAINTENANCE MATERIALS

A. Refer to Section 017000 for requirements of spare parts and maintenance products.

B. Furnish two containers of lubricating oil.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. Site Altitude: Chiller shall be suitable for altitude in which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

2.2 PACKAGED WATER CHILLERS

A. Manufacturers:

1. Daikin Applied
2. Trane
3. Carrier Global Corporation

B. Product Description: Factory assembled and tested, packaged, water chillers consisting of compressors, compressor motor, condenser, evaporator, refrigeration accessories, instrument and control panel including gages and indicating lights, auxiliary components and accessories, and motor starters.

2.3 HERMETIC COMPRESSORS

A. Reciprocating Compressors:

1. Unit: Hermetically sealed motor-compressor with crankcase heater, suction and discharge service valves, rubber-in-shear isolators, and control panel.
2. Motor: Constant speed 3600 rpm, suction gas cooled with overheating protection.
3. Crankcase Heater: Energize when compressor is not operating.

B. Scroll Compressors:

1. Unit: Direct drive, hermetic, 3600 RPM, fixed compression, scroll motor-compressor with control panel.
2. Features: Centrifugal oil pump, sump oil heater, oil level sight glass, oil charging valve, two-point lubrication for each motor bearing, flooded lubrication for journal and thrust bearings, check valve on scroll discharge port.
3. Motor: Suction-gas cooled, hermetically sealed, squirrel cage induction.
4. Automatic Capacity Reduction**:** Wire steps to terminal strip. Refer to Section 230993.

2.4 SEMI-HERMETIC COMPRESSORS

A. Reciprocating Compressors:

1. Unit: Serviceable hermetic reciprocating motor-compressor with positive displacement oil pump lubrication system, spring loaded heads and replaceable cylinder liners, crankcase heater, suction inlet screen, discharge service valves, and control panel.
2. Automatic Capacity Reduction Equipment solenoid or gas pressure operated. Furnish capability for unloaded compressor start.
3. Motor: Constant speed 1800 rpm, suction gas cooled with electronic overheating protection in each phase, full voltage starting.
4. Crankcase Heater: Energize when compressor is not operating.

B. Screw Compressors:

1. Unit: Direct drive, semi-hermetic 3600 RPM, fixed compression, rotary screw compressor with control panel.
2. Features: Differential refrigerant pressure oil pump, oil heater, oil separator and filter and oil charging valve.
3. Motor: Suction gas-cooled, hermetically sealed, squirrel cage induction.
4. Automatic Capacity Reduction: Continuously variable slide valve with infinitely variable control to 25 percent of full load.

2.5 EVAPORATOR

A. Shell and tube type, seamless or welded steel construction with cast iron or fabricated steel, heads, seamless copper tubes or red brass tubes with integral fins, rolled or silver brazed into tube sheets. Furnish multiple refrigerant circuits on multiple compressor units.

B. Design, test, and stamp refrigerant side for 225 psig working pressure and water side for 150 psig working pressure, in accordance with ASME Section VIII.

C. Insulate with 0.75-inch minimum thick flexible insulation with maximum K factor of 0.28.

D. Furnish water drain connection and thermometer wells for temperature controller and low temperature cutout.

2.6 CONDENSERS

A. Shell and tube type, seamless or welded steel construction with cast iron or fabricated steel, heads, seamless copper tubes or red brass tubes with integral fins, rolled or silver brazed into tube sheets.

B. Design, test, and stamp refrigerant side for 450 psig working pressure in accordance with ASME Section VIII.

C. Furnish integral sub-cooling circuit.

D. Furnish 450 psig safety relief valve on condenser shell.

E. Design, test, and stamp water side for 150 psig working pressure in accordance with ASME Section VIII.

2.7 CONDENSER COILS, FANS AND MOTORS

A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Furnish sub-cooling circuits as applicable. Air test under water to 425 psig and dehydrate. Seal with holding charge of nitrogen or refrigerant.

B. Coil Guard: Expanded metal or Louvered, with lint screens.

C. Configuration: Single refrigeration circuit or two refrigeration circuits each with receiver.

D. Vertical direct driven propeller type condenser fans with fan guard on discharge, equipped with roller or ball bearings with grease fittings extended to outside of casing.

E. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built-in current and thermal overload protection. Refer to Section 230513.

2.8 REFRIGERANT CIRCUIT

A. Factory furnished and piped.

B. Furnish for each refrigerant circuit:

1. Liquid line solenoid valve.
2. Filter dryer (replaceable core type).
3. Liquid line sight glass and moisture indicator.
4. Thermal expansion for maximum operating pressure.
5. Charging valve.
6. Insulated suction line.
7. Discharge line check valve.
8. Compressor discharge service valve.
9. Pressure relief device.

2.9 CONTROLS

A. On or near chiller, mount steel control panel with enclosure, containing starters, power and control wiring, molded case disconnect switch, factory wired with single point power connection.

B. For each compressor, furnish across-the-line starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for control power. Furnish manual reset, current overload protection.

C. Furnish devices on control panel face:

1. Compressor, run lights.
2. System start-stop switch.

3. Control power fuse of circuit breaker.
4. Compressor lead-lag switch.
5. Demand limit switch.

D. Furnish safety controls with indicating lights arranged so machine is shut down and requires manual reset:

1. Low chilled water temperature switch.
2. High discharge pressure switch for each compressor.
3. Low suction pressure switch for each compressor.
4. Oil pressure switch.
5. Flow switch in chilled water line.
6. Flow switch in condenser water line.
7. Relay for remote mounted emergency shutdown.

E. Furnish the following operating controls:

1. Multi-step chilled water temperature controller to cycle compressor and activate capacity controls, with remote thermostat.
2. Five minute off timer prevents compressor from short cycling.
3. Part winding start timer.
4. Periodic pump-out-timer to pump down on chilled water flow and high evaporator refrigerant pressure.
5. Solenoid valve between heat recovery condenser and receiver to limit refrigerant level in condenser.
6. Controls for operation down to 20 degrees F ambient temperature.
7. Thermostat to cycle fan motors in response to out-door ambient temperature.
8. Head pressure switch to cycle fan motors in response to refrigerant condensing pressure.
9. Solid state control to vary speed of one condenser fan motor in response to refrigerant condensing pressure.
10. Electronic low ambient control consisting of mixing damper assembly, controlled to maintain constant refrigerant condensing pressure.
11. Load limit thermostat to limit compressor loading on high return water temperature.
12. Three phase monitor to protect unit by stopping compressor on phase loss, phase reversal, phase unbalance, or under voltage.
13. Hot gas bypass sized for minimum compressor loading, bypasses hot refrigerant gas to evaporator.
14. Cycle counter and operating hour meter.

F. Furnish pre-piped gage board with pressure gages for suction and discharge refrigerant pressures, and oil pressures for each compressor.

G. Furnish alarm package with test button and lights indicating control circuit is energized, compressor is running, and sounds audible alarm and activates indicating light upon detection of compressor malfunction, low chilled water temperature, or evaporator water flow failure.

H. For multiple units, furnish remote mounted sequence panel to allow operation in parallel with lead-lag switching.

2.10 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Components:

1. Motor starters shall have a UL 1995 gasket enclosure. Enclosure shall be constructed of 14-gauge steel minimum.
2. Starters shall be unit mounted with ventilating louvers.
3. Motor starters shall include incoming line provisions for the number and size cables shown on the drawings. Incoming line lugs shall be aluminum mechanical type. Connection directly to the contactors is not permissible.
4. Contactors shall be sized properly to the chiller full load and locked rotor currents. Contactors shall have double break main contacts with weld resistant silver cadmium faces. Auxiliary interlocks that interface with the control panel shall be low resistance having palladium silver contacts.
5. Each motor starter shall include a control power transformer with fused primary and secondary. Current transformers of the proper size, ratio and burden capacity shall be provided to provide a signal to the control panel and optional devices. Control relays shall be provided within the motor starter to interface with the control panel.
6. Factory installed control power transformer shall also be capable of providing 115V power for optional field-installed water regulating valve (water-cooled condenser only)
7. Each starter shall include an advanced motor protection system incorporating electronic three phase overloads and current transformers. This electronic motor protection system shall monitor and protect against the following conditions:

    a. Three phase overload protection
    b. Overload protection during start-up
    c. Phase imbalance
    d. Phase loss
    e. Phase reversal
    f. Low voltage
    g. Under/over voltage protection

8. Alternately the advanced motor protection system can be furnished in the chiller control panel.
9. Each starter/control shall be designed and able to operate in temperatures up to 104 F.
10. All field supplied wires, bus bars, and fittings shall be copper only.
11. Provide in the starter panel:

    a. Circuit Breaker - The disconnect handles, both internal and external, shall be capable of being padlocked in the off position.
    b. Amps (standard) and volts shall be displayed at the control panel or ammeters and voltmeters provided. Three ammeters shall be provided, one per phase. Ammeters shall be calibrated to indicate the inrush current. Three voltmeters shall be provided, each reading a phase-to-phase voltage.

12. Provide Short Circuit Rating of 65,000 Amps for an Across the Line starter based on the corresponding power connection type. The Short Circuit Rating is the rating of the panel to withstand a short circuit of the specified amps. This rating is separate from the AIC rating of Circuit Breakers.

B. Electrical Characteristics:

C. Motors: In accordance with Section 230513.

D. Disconnect Switch: Factory mount in control panel or on equipment.

2.11 SOURCE QUALITY CONTROL AND TESTS

A. Furnish testing and analysis of package chillers.

B. Furnish shop inspection and testing for package chillers prior to shipping. Factory run test each chiller with water flowing through evaporator.

C. For chillers located outdoors, rate sound power level according to AHRI 370.

D. Allow witnessing of factory inspections and tests at manufacturers test facility. Furnish at least 21 days' notice before inspections and tests are scheduled.

E. Noise rating: 74 dBA. Provide factory-installed sound treatment to obtain 65 dBA sound pressure level performance when measured according to AHRI 370.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

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

3.2 INSTALLATION

A. Equipment Mounting:

1. Install indoor chiller on concrete housekeeping pad per design drawings. Refer to Section 033000.
2. Install packaged outdoor chiller on concrete foundation per design drawings. Refer to Section 033000.
3. Install dowel rods to connect steel base to concrete pad. Unless otherwise indicated, install dowel rods on centers in accordance with manufacturer’s installation recommendations.

4. For supported equipment, install epoxy coated anchor bolts that extend through concrete pad.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Install the following piping accessories on evaporator chilled water piping connections.

1. On inlet:

    a. Shut-off valve.
    b. Strainer.
    c. Flexible pipe connector.
    d. Thermometer.
    e. Pressure gauge.

2. On outlet:

    a. Shut-off valve.
    b. Balancing valve.
    c. Flexible Pipe connector.
    d. Flow switch.
    e. Thermometer.
    f. Pressure gauge.
    g. Flow meter.

C. Install auxiliary water piping for oil cooling units and purge condensers.

D. Install the following piping accessories on condenser water piping connections.

1. On inlet:

    a. Shut-off valve.
    b. Strainer.
    c. Flexible pipe connector.
    d. Thermometer.
    e. Pressure gauge.

2. On outlet:

    a. Shut-off valve.
    b. Balancing valve.
    c. Flexible Pipe connector.
    d. Flow switch.
    e. Thermometer.
    f. Pressure gauge.
    g. Flow meter.

E. Arrange piping for easy dismantling to permit tube cleaning.

F. Install refrigerant piping connections to air-cooled condensing units.

G. Install piping from chiller safety relief valve to outdoors. Size as recommended by manufacturer.

H. Install chiller accessories furnished loose for field mounting.

I. Install electrical devices furnished loose for field mounting.

J. Install control wiring between chiller control panel and field mounted control devices.

K. Provide connection to electrical service.

3.3 CONNECTIONS

A. Install piping to chiller to allow service and maintenance.

B. Connect each chiller drain connection with a union and drain pipe, and extend pipe full size of connection to floor sink. Provide a shut-off valve at each connection.

C. Evaporator Fluid Connections: Connect to evaporator inlet with shut-off valve, strainer, flexible connector, thermometer, and plugged tee with pressure gauge. Connect to evaporator outlet with shut-off valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shut-off valve and pressure gauge, flow meter, and drain connection with valve. Make connections to the chiller with a flange connection.

D. Condenser Fluid Connections: Connect to condenser inlet with shut-off valve, strainer, flexible connector, thermometer, and plugged tee with pressure gauge. Connect to condenser outlet with shut-off valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shut-off valve and pressure gauge, flow meter, and drain connection with valve. Make connections to the chiller with a flange connection.

3.4 FIELD QUALITY CONTROL

A. Furnish cooling season start-up, winter season shutdown service, for first year of operation. When initial start-up and testing takes place in winter and machines are to remain inoperative, repeat start-up and testing operation at beginning of first cooling season.

3.5 MANUFACTURER'S FIELD SERVICES

A. Furnish services of factory trained representative to perform startup services:

1. Leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Owner on operation and maintenance.
2. Verify that pumps are installed and functional.
3. Verify that thermometers and gauges are installed.
4. Operate chiller for run-in period.
5. Check bearing lubrication and oil levels.
6. Verify proper motor rotation.
7. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.

8. Verify and record performance of fluid flow and low-temperature interlocks for evaporator.
9. Verify and record performance of chiller protection devices.
10. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Furnish initial charge of refrigerant and oil.

C. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

D. Prepare test and inspection startup reports.

E. Provide coordination with Controls Contractor and full assistance in mapping chiller points to plant HVAC controls.

3.6 DEMONSTRATION AND TRAINING

A. Demonstrate system operations and verify specified performance. Demonstrate low ambient operation during winter testing for air-cooled condensers.

B. Engage a factory-authorized service representative to train CAWCD maintenance personnel to adjust, operate, and maintain chillers.

END OF SECTION 236400

SECTION 236500 - COOLING TOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Open-circuit, induced-draft, counterflow cooling towers.

1.2 ACTION SUBMITTALS

A. Product Data (PD): For each cooling tower indicated.

1. Provide manufacturer literature, which indicates dimensions, weights, rated capacities, fan performance data, material finishes, electrical characteristics including wiring diagrams, and pipe connection requirements.
2. Provide data for all furnished specialties and accessories.
3. Provide fan curves with selected points indicated.
4. Submit sound power level data.

B. Shop Drawings (SD):

1. Submit complete set of manufacturer's prints of cooling tower assemblies, control panels, sections and elevations, and unit isolation.
2. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

C. Operation and Maintenance Data: Include O&M data in final O&M Manuals submitted to CAWCD.

1.3 QUALITY ASSURANCE

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

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. ASME Compliance: Fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. CTI Certification: Cooling tower thermal performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

E. FMG approval and listing in the latest edition of FMG's "Approval Guide."

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace all components of cooling towers that fail in materials or workmanship within specified warranty period:

1. Warranty Period: Five years from date of Startup.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design cooling tower support structure, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Wind-Restraint Performance:

1. Basic Wind Speed: 115 mph (three second gust).
2. ASCE 7 Risk Category: III.
3. Minimum 30 lb/sq. ft multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
4. ASCE 7 Seismic Design Category: E

C. Seismic Performance: Cooling towers shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.2 OPEN-CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

A. Manufacturers:

1. REYMSA; RT Series (basis of design).
2. Evapco Inc.; Models AT (upon approval from CAWCD as an alternate).
3. Or alternate as approved by CAWCD.

B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.

C. Casing and Frame:

1. Casing and Frame Material: Stainless steel (Type 304).
2. Fasteners: Stainless steel.

3. Joints and Seams: Sealed watertight.
4. Welded Connections: Continuous and watertight.

D. Collection Basin:

1. Material: Stainless steel (Type 304).
2. Strainer: Removable stainless-steel strainer with openings smaller than nozzle orifices.
3. Overflow and drain connections.
4. Makeup water connection.
5. Outlet Connection: ASME B16.5, Class 150 flange.
6. Removable equalization flume plate between adjacent cells of multiple-cell towers.
7. Equalizer connection for field-installed equalizer piping.

E. Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:

1. Enclosure: NEMA 250, Type 4X.
2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level.
3. Electrode Probes: Stainless steel.
4. Water Stilling Chamber: Stainless steel.
5. Solenoid Valve: Slow closing with stainless-steel body, controlled and powered through level controller in response to water-level set point.
6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

F. Pressurized Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat-exchanger coil or fill throughout the flow range without the need for balancing valves and for connecting individual, removable, non-clogging spray nozzles.

1. Pipe Material PVC.
2. Spray Nozzle Material: ABS.
3. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

G. Fill:

1. Materials: PVC, resistant to rot, decay, and biological attack; with maximum flame-spread index of 5 according to ASTM E 84.
2. Minimum Thickness: 20 mils, before forming.
3. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
4. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F.

H. Removable Drift Eliminator:

1. Material: PVC; resistant to rot, decay, and biological attack; with maximum flame-spread index of 5 according to ASTM E 84.

2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.

I. Air-Intake Louvers:

1. Material: PVC.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
4. Removable Air-Intake Screens: Stainless-steel wire mesh.

J. Axial Fan: Balanced at the factory after assembly.

1. Blade Material: Aluminum.
2. Hub Material: Aluminum.
3. Blade Pitch: Field adjustable.
4. Protective Enclosure: Removable, stainless-steel, wire-mesh screens, complying with OSHA regulations.
5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 75,000 hours.
6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
7. Fan Guard: Stainless Steel.
8. Direct drive preferred.

K. Belt Drive: (Only as approved by CAWCD)

1. Service Factor: 1.5 based on motor nameplate horsepower.
2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.

    a. Belt: Multiple V-belt design with a matched set of cogged belts.
    b. Belt: One-piece, multi-grooved, solid-back belt.
    c. Belt Material: Oil resistant, non-static conducting, and constructed of neoprene polyester cord.
    d. Belt-Drive Guard: Comply with OSHA regulations.

L. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Section 230513 and not indicated below.
2. Motor Enclosure: Totally enclosed air over (TEAO with epoxy or polyurethane finish.
3. Energy Efficiency: Comply with ASHRAE/IESNA 90.1 and NEMA Premium Efficient.
4. Service Factor: 1.15.
5. Insulation: Class F.

6. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
7. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
8. Severe-duty rating with the following features:

    a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
    b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F
    c. Internal heater automatically energized when motor is de-energized.

9. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

M. Fan Discharge Stack: Stainless steel.

1. Stack Termination: Wire-mesh, stainless-steel screens complying with OSHA regulations.

N. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 4X.
2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
3. Provide switch with manual-reset button for field connection to a BMS and hardwired connection to fan motor electrical circuit.
4. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and shut down the fan.

O. Controls: Comply with requirements in Section 230900.

P. Control Package: Factory installed and wired, and functionally tested at factory before shipment.

1. NEMA 250, Type 4X enclosure with removable internally mount back plate.
2. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
6. Collection basin level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve" Paragraph.
7. Vibration switch for each fan, complying with requirement in "Vibration Switch" Paragraph.
8. Single-point, field-power connection to a fused disconnect switch for each cooling tower cell.

a. Branch power circuit to each motor and to controls with a disconnect switch.
b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

9. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquid tight conduit.
10. Visual indication of status and alarm with momentary test push button for each motor.
11. Audible alarm and silence switch.
12. Visual indication of elapsed run time, graduated in hours for each motor.
13. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:

    a. Operational status of each motor.
    b. Position of dampers.
    c. Cooling tower leaving-fluid temperature.
    d. Fan vibration alarm.
    e. Collection basin high- and low-water-level alarms.
    f. Fan motor amperage: Provide current switch for each fan motor

Q. Personnel Access Components:

1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
2. External Ladders: Shall comply with CAP standards.
3. Handrail and Platform: Shall comply with CAP standards.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Test and certify cooling tower performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

B. Factory pressure test heat exchangers after fabrication and prove to be free of leaks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine cooling towers before installation. Reject cooling towers that are damaged.

B. Examine roughing-in for tower support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting cooling tower performance, maintenance, and operation before equipment installation.

1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.

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

3.2 INSTALLATION

A. Install cooling towers on support structure indicated.

B. Equipment Mounting:

1. Install cooling towers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000.
2. Install vibration isolation devices as recommended by manufacturer.

C. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to cooling towers to allow service and maintenance.

C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.

D. Provide drain piping with valve at cooling tower drain connections and at low points in piping.

E. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.

F. Domestic Water Piping: Connect to water-level control with shutoff valve and union, flange, or mechanical coupling at each connection.

G. Supply and Return Piping: Connect to entering cooling tower connections with shutoff valve, strainer, balancing valve, thermometer, plugged tee with pressure gauge, flow meter, and drain connection with valve. Connect to leaving cooling tower connection with shutoff valve. Make connections to cooling tower with a flange.

H. Equalizer Piping: Piping requirements to match supply and return piping. Connect an equalizer pipe, full size of cooling tower connection, between tower cells. Connect to cooling tower with shutoff valve.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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

B. Tests and Inspections: Comply with CTI ATC 105, "Acceptance Test Code for Water Cooling Towers."

C. Cooling towers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Obtain performance data from manufacturer.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Clean entire unit including basins.
b. Verify that accessories are properly installed.
c. Verify clearances for airflow and for cooling tower servicing.
d. Check for vibration isolation and structural support.
e. Lubricate bearings.
f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
g. Adjust belts to proper alignment and tension.
h. Verify proper oil level in gear-drive housing. Fill with oil to proper level.
i. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
j. Check vibration switch setting. Verify operation.
k. Verify water level in tower basin. Fill to proper startup level. Check makeup water-level control and valve.
l. Verify operation of basin heater and control.
m. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
n. Replace defective and malfunctioning units.

D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

E. Prepare a written startup report that records the results of tests and inspections.

3.6 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water-level control for proper operating level.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train CAWCD maintenance personnel to adjust, operate, and maintain cooling towers.

END OF SECTION 236500

SECTION 237313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air handling units with coils for indoor installation.

1.2 ACTION SUBMITTALS

A. Product Data (PD): For each air-handling unit indicated.

1. Provide manufacturer literature, which indicates dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, electrical characteristics, and connection requirements.
2. Provide data on filter media, filter performance data, filter assembly, and filter frames.
3. Provide fan curves with specified operating point clearly plotted. Provide both individual fan curves with AMCA Certification and non-certified composite curves for fan arrays.
4. Submit sound power level data for the air handling unit outlet, inlet and casing radiated at rated capacity and specified pressure.
5. Submit electrical requirements for power supply including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring.

B. Shop Drawings (SD):

1. Submit complete set of manufacturer's prints indicating unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics, and connection requirements.
2. Wiring Diagrams: Power, signal, and control wiring.
3. Piping connection points, including chilled water, refrigerant piping, and condensate piping.
4. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data: Include instructions for inspection, maintenance, lubrication, filter replacement, motor and drive replacement, adjustments, spare parts lists, and wiring diagrams.

1.4 QUALITY ASSURANCE

A. Comply with requirements of UL Standard 1995 and include label by a qualified testing agency showing compliance.

B. Conform to all information documented in approved submittal package and construction notes.

C. Fan vibration test results shall be made available to the engineer for review upon request.

D. Manufacturer shall have a documented quality assurance plan for providing consistent product quality. The quality assurance plan shall include component quality check lists, random product inspections, fan balance reports, coil and piping leak test reports, electrical system test reports, etc. Copies of these reports shall be made available to the engineer upon request.

E. Seismic Compliance (if applicable):

1. The complete unit shall be independently certified compliant with the seismic requirements of the applicable version of the International Building Code (IBC) for the building classification and site conditions indicated in the bid documents. Certification means that the unit will stay online and functional following a seismic event. The manufacturer shall confirm compliance at time of bid by providing a Certificate of Compliance from a certified Seismic Qualification Agency.
2. The unit shall be clearly labeled for field inspection, displaying an IBC Compliance Label issued by an independent third-party approval agent. Labels shall clearly identify the manufacturer, unit model number, unit serial number and information describing unit performance characteristics, seismic conformance level (if applicable) and the approval agency's identification.
3. Manufacturer's Submittal documents shall include an IBC Certificate of Compliance clearly indicating the equipment model being submitted.
4. Unit shall be rated to withstand the effects of gravity and seismic loads and stresses according to ASCE/SEI 7.

    a. Risk Category III
    b. Seismic Design Category E

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. All work shall be in compliance with NFPA 70.

G. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

H. AHRI Certification: Air-handling units and their components shall be factory tested according to AHRI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by AHRI.

I. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

J. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in designing and manufacturing products specified in this section with a minimum of ten years documented experience, and which publishes equipment product data.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 EXTRA MATERIALS

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

1. Filters.
2. Gaskets.
3. Fan Belts.
4. Heat Wheel Belts.

B. Provide one spare plenum fan assembly per unit type for products with fan walls.

1.7 DELIVERY STORAGE AND HANDLING

A. Deliver, store, protect and handle under the supervision of CAWCD and in accordance with the manufacturer's Operation & Maintenance manuals. Store in a clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

B. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated, and the fan(s) has been test-run under observation.

C. Equipment shall be covered by factory applied shrink wrap material to protect it from accumulating dirt or moisture during transit. The covering shall include a minimum of one zippered opening to allow field access for preventing interior condensation during storage.

D. Installation:

1. Assemble and install in strict accordance with manufacturer's Operation & Maintenance Instructions, shop drawings and contract documents.

1. Verify all components, accessories and appurtenances are on site.
2. Align, level, bolt in place and grout.
3. Install in conformance with AHRI 430.

E. Manufacturer shall provide with each unit complete Installation, Operation & Maintenance manuals at time of shipment.

1.8 WARRANTY

A. Manufacturer shall provide the complete unit with a full parts two-year warranty. The warranty period shall begin on date of start-up.

B. The installing contractor shall provide two-year full labor warranty. The warranty period shall begin on date of substantial completion.

C. Warranty terms and conditions are to be included in the project submittal.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: (Alternates only accepted with prior approval from CAWCD)

1. Basis of design is Energy Labs.
2. Alternative Manufacturers:

    a. Daikin Applied
    b. Trane
    c. Carrier Global Corporation

2.2 UNIT CASING

A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets.
3. Sections shall be joined by bolting through a neoprene gasket joint.
4. Sealing: Seal all joints with water-resistant sealant. Hermetically seal at each corner and around entire perimeter.
5. Base Rails or Legs: Galvanized steel.

B. Double Wall Construction:

1. Outside Casing: Galvanized steel, or aluminum, minimum 16 gage thick.
2. Inside Casing: Perforated Galvanized steel, minimum 18 gage thick, perforated aluminum, minimum 16 gage thick.
3. Floor Plate: Galvanized steel, 0.1382 inch thick.

C. Casing Insulation:

1. Glass-fiber blanket or board insulation, Type I or Type II ASTM C 1071 or injected polyurethane foam insulation. Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of unit.

2. Comply with NFPA 90A or NFPA 90B.
3. Thickness: 2-inch on double-wall units.
4. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
5. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.

D. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Painting:

1. All panels (walls and roof) shall be coated with polyurethane primer and Polyester-Hybrid semi-gloss topcoat. Paint shall be baked at 450 degrees F for superior adhesion and uniformity. All panels are primed and top coated on both sides. Paint system shall offer excellent color retention and low fade characteristics, excellent resistance to UV, solvents and chemical fumes and very good abrasion resistance. Paint system shall pass a minimum of 1000 hours salt spray test per ASTM B-117. Test documentation shall be available upon request.
2. The entire structural steel base of the unit as well as the fan assembly shall be painted with alkyd enamel. Industrial grade alkyd enamel red oxide primer shall be applied by air brush to 2 mills thickness and alkyd enamel topcoat shall be applied by air brush to 2-3 mils thickness, for a total dry thickness of 4-5 mils.

F. Panels:

1. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
2. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement is to allow panels to be opened against airflow.
3. Gasket: Neoprene, applied around entire perimeters of panel frames.
4. Size: Large enough to allow unobstructed access for inspection and maintenance of internal components. At least 24 inches wide by full height of unit casing up to a maximum height of 60 inches.

G. Access Doors:

1. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
2. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors to prevent uncontrolled openings.
3. Gasket: Neoprene, applied around entire perimeters of door frames.
4. Size: Large enough to allow unobstructed access for inspection and maintenance of internal components. At least 24 inches wide by full height of unit casing up to a maximum height of 60 inches.
5. Viewport: Double thickness, wire reinforced glass mounted in a gasketed frame.

H. Locations and Applications:

1. Verify that the sections listed below are large enough for panels and doors. Verify applicability with listed manufacturers.

a. Fan Section: Doors.
b. Access Section: Doors.
c. Coil Section Doors.
d. Filter Section: Doors large enough to allow periodic removal and installation of filters.

I. Condensate Drain Pans:

1. Locate at each cooling coil.
2. Single-wall, 3/16 stainless-steel sheet.
3. Minimum one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
4. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
5. Width: Entire width of coil.
6. Depth: A minimum of 2 inches deep.
7. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan on the accessible side of the unit.
8. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
9. Top coil pans shall extend minimum 8” beyond coil face, bottom coil pans shall extend minimum 18” beyond coil face.

2.3 FAN, DRIVE, AND MOTOR SECTION

A. Fan Assembly:

1. Fans shall be of the size and type shown in the project Schedule and shall perform as indicated. The fan wheel diameter shall not be less than that shown on the equipment schedule. Fans shall be constructed to AMCA Standards for the Class Rating as indicated on the Equipment Schedule.
2. Fan performance shall be based on tests run in an AMCA accredited laboratory and administered in accordance with AMCA Standards 210 and 300. Fans shall be licensed to bear the AMCA seal for air and sound performance.
3. Unit fan performance shall be adjusted to reflect fans running inside the cabinet such that it reflects any effects from the unit cabinet, fan configuration or other internal components. Performance shall be based on unit tests run in an AMCA 210 and 300 accredited laboratory.
4. Fan and motor shall be mounted on an internal, fully welded, rigid steel assembly. Each individual fan assembly shall be free-floating at all four corners on minimum 2” deflection spring isolators with seismic restraints. The spring isolators shall be mounted to structural steel members and shall be rated for a minimum of 1G. The fan discharge shall be isolated from the cabinet by means of a neoprene-coated flexible connection.
5. Units without individually spring isolated fans must provide comparable isolation for the entire air handling unit. Units utilizing non-spring isolated fans are not acceptable.
6. An overhead motor removal rail sized for the specific motor weight shall be provided.

B. Fans shall be compliant with requirements specified in Section 233400. Motors shall be compliant with requirements specified in Section 230513.

C. Fans shall be provided with a vertical blade, near zero pressure drop back draft damper that shall close in the event of a motor failure to prevent air bypass through the off fan. Any damper pressure loss shall be reflected in fan performance

2.4 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with AHRI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Refer to Drawings for coil capacities and arrangement in unit.
4. Coils shall not act as structural component of unit.
5. Water Coils: Drainable coil fabricated according to AHRI 410.
6. Piping Connections: On same end.
7. Tubes: Copper, complying with ASTM B75.
8. Fins: Aluminum, maximum 144 fins per foot.
9. Fin and Tube Joint: Mechanical bond.
10. Headers: Cast iron with drain and air vent tappings or seamless copper tube with brazed joints, prime coated.
11. Frames: Type 304 stainless-steel channel frame and supports.

B. Design tested and rate according to ASHRAE 33 and AHRI 410 for working pressure of 200 psig at 200 degrees F.

C. Source Quality Control: Test to 300 psig and to 200 psig underwater.

2.5 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Refer to Drawings for filter efficiency and type. Filters shall be minimum MERV-13 unless noted otherwise on drawings.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on drive side of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Filter Pressure Gauge:

1. 3-1/2-inch- diameter, diaphragm-actuated dial in metal case.
2. Vent valves.
3. Black figures on white background.
4. Front recalibration adjustment.
5. 2 percent of full-scale accuracy.
6. Range: 0- to 2.0-inch wg.

7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum tubing, and 2- or 3-way vent valves.

2.6 DAMPERS

A. Control Dampers: Comply with requirements in Section 233300.

B. Outdoor- and Return-Air Mixing Dampers: Parallel-blade, galvanized-steel dampers mechanically fastened to steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

C. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.

D. Combination Filter and Mixing Section:

1. Cabinet support members shall hold 2-inch-thick, pleated, flat, permanent, or throwaway filters.
2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.7 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to AHRI 410 and ASHRAE 33.

2.8 ELECTRICAL POWER SERVICE

A. General Requirements:

1. Supply fan arrays shall be factory wired to a motor control center with flexible conduit of adequate length so that it will not affect vibration isolation. Motor control center shall include motor overload protection, short circuit protection, manual disconnecting means and a power distribution block for connection to a field supplied VFD.
2. Wiring shall be clearly labeled to allow for ease of final field connections and shall be run in EMT conduit. Raceways are not acceptable.
3. The air handling unit manufacturer, for the purpose of sole source responsibility, shall manufacture all electrical panel assemblies supplied for the air handlers. The air handling unit manufacturer shall have a UL 508 listed panel shop.

B. Lights:

1. Provide factory installed marine type light fixtures in each air handling unit section serviced by a door. Cabinets >14' in width shall have two fixtures per section. Fixtures to be factory wired to a single 60-minute timer switch located on the unit exterior at the supply fan section door. A 15-amp GFCI convenience outlet shall be mounted with the light switch. The electrical contractor shall bring a separate 120/60/1 power service to operate the GFCI & lighting circuit. Lamps to be LED.

PART 3 - EXECUTION

3.1 CLEANLINESS STANDARD

A. Prior to shipment, all internal surfaces including filter frames, coil faces, and housing shall be vacuum cleaned, wiped clean and seal off all openings before shipment.

3.2 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Replace with new insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping systems and electrical services to verify actual locations of connections before installation.

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

3.3 INSTALLATION

A. Equipment Mounting: Install air-handling units on minimum 6" rails. Adjust rail size as required to meet job specific requirements.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

E. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

F. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

G. Install piping adjacent to air-handling unit to allow service and maintenance.

H. Connect condensate drain pans using NPS 1-1/4, as required in Section 230503. Extend to nearest equipment or floor drain. Construct a deep trap at connection to drain pan and install cleanouts at changes in direction.

I. Chilled-Water Piping: Comply with applicable requirements in Section 230503 and Section 230523. Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

J. Coordinate duct installations and specialty arrangements with schematics on Drawings and with requirements specified in Section 233113 and Section 233300.

K. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.4 MANUFACTURER'S FIELD SERVICES

A. Engage a factory trained representative to perform start-up services:

1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized. Start units to confirm proper motor rotation and unit operation.
3. Prepare test and inspection reports.

3.5 DEMONSTRATION AND TRAINING

A. Demonstrate system operations and verify specified performance. Demonstrate low ambient operation during winter testing for air-cooled condensers.

B. Engage a factory-authorized service representative to train CAWCD maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313

SECTION 237413 - OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
2. Hot water coils.
3. Chilled water coils
4. Economizer outdoor- and return-air damper section.
5. Roof curbs.

1.2 DEFINITIONS

A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

B. Supply-Air Fan: The fan providing supply-air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.3 ACTION SUBMITTALS

A. Product Data (PD): For each air-handling unit indicated.

1. Provide manufacturer literature, which indicates dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, electrical characteristics, and connection requirements.
2. Provide data on filter media, filter performance data, filter assembly, and filter frames.
3. Provide fan curves with specified operating point clearly plotted. Provide both individual fan curves with AMCA Certification and non-certified composite curves for fan arrays.
4. Submit sound power level data for the air handling unit outlet, inlet and casing radiated at rated capacity and specified pressure.
5. Submit electrical requirements for power supply including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring.

B. Shop Drawings (SD):

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: Power, signal, and control wiring.

3. Piping connection points, including chilled water, refrigerant piping, and condensate piping.
4. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data: Include instructions for inspection, maintenance, lubrication, filter replacement, motor and drive replacement, adjustments, spare parts lists, and wiring diagrams. Include O&M data in final O&M Manuals submitted to CAWCD.

1.5 QUALITY ASSURANCE

A. AHRI Compliance:

1. Comply with AHRI 203/110 and AHRI 303/110 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigerant system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with requirements of UL 1995 and include label by a qualified testing agency showing compliance.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in designing and manufacturing products specified in this section with a minimum of ten years documented experience, and which publishes equipment product data.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 EXTRA MATERIALS

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

1. Filters.
2. Gaskets.
3. Fan Belts.

1.8 DELIVERY STORAGE AND HANDLING

A. Deliver, store, protect, and handle under the supervision of CAWCD and in accordance with the manufacturer's Operation & Maintenance manuals. Store in a clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

B. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated, and the fan(s) has been test run under observation.

C. Equipment shall be covered by factory applied shrink wrap material to protect it from accumulating dirt or moisture during transit. The covering shall include a minimum of one zippered opening to allow field access for preventing interior condensation during storage.

D. Installation:

1. Assemble and install in strict accordance with manufacturer's Operation & Maintenance Instructions, shop drawings and contract documents.

1. Verify all components, accessories and appurtenances are on site.
2. Align, level, bolt in place and grout.
3. Install in conformance with AHRI 430.

E. Manufacturer shall provide with each unit complete Installation, Operation & Maintenance manuals at time of shipment.

1.9 WARRANTY

A. Manufacturer shall provide the complete unit with a full parts two-year warranty. The warranty period shall begin on date of start-up.

B. The installing contractor shall provide two-year full labor warranty. The warranty period shall begin on date of substantial completion.

C. Warranty terms and conditions are to be included in the project submittal.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Performance:

1. Basic Wind Speed: 115 mph (three second gust).
2. ASCE 7 Risk Category: III
3. Minimum 30 lb/sq. ft multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
4. ASCE 7 Seismic Design Criteria: E

B. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.”

2.2 MANUFACTURERS

A. Manufacturers: (Alternatives only accepted with prior approval from CAWCD)

1. Basis of design: Trane; American Standard Companies, Inc.
2. Carrier Corporation
3. McQuay International
4. YORK International Corporation
5. Daikin Applied

2.3 UNIT CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Double Wall Construction:

1. Exterior Casing Material: Galvanized steel with factory-painted enamel finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

a. Exterior Casing Thickness: 0.052 inch thick.

2. Inside Casing Material: Galvanized steel, 0.034 inch thick, perforated 40 percent free area in fan sections, inlet plenums, access, and discharge plenum sections. Stainless steel, 0.034-inch-thick solid panel in chilled water coil, direct expansion coil, and mixing boxes.
3. Floor Plate: Galvanized steel, 0.1382 inch thick.

C. Casing Insulation:

1. Comply with NFPA 90A or NFPA 90B.
2. Materials: ASTM C 1071, Type I.

3. Thickness: 2 inches.
4. R-value: 13
5. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
6. Liner Adhesive: Comply with ASTM C 916, Type I.

D. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Casing air leakage shall not exceed leak class 9 per ASHRAE 111 at 1.25 times maximum casing static pressure up to a maximum of +/- 8 inches w.g. in positive and negative pressure sections.

F. Roof casing to be sloped a minimum of 0.125-inches per foot to permit rainwater run-off. Provide internal thermal breaks.

G. Panels:

1. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
2. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement is to allow panels to be opened against airflow.
3. Gasket: Neoprene, applied around entire perimeters of panel frames.
4. Size: Large enough to allow unobstructed access for inspection and maintenance of internal components. At least 24 inches wide by full height of unit casing up to a maximum height of 60 inches.

H. Access Doors:

1. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
2. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors to prevent uncontrolled openings.
3. Gasket: Neoprene, applied around entire perimeters of door frames.
4. Size: Large enough to allow unobstructed access for inspection and maintenance of internal components. At least 24 inches wide by full height of unit casing up to a maximum height of 60 inches.

I. Locations and Applications:

1. Verify that the sections listed below are large enough for panels and doors. Verify applicability with listed manufacturers.

    a. Fan Section: Doors.
    b. Access Section: Doors.
    c. Coil Section: Doors.
    d. Filter Section: Doors large enough to allow periodic removal and installation of filters.

2.4 Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep**,** and complying with ASHRAE 62.1.

1. Locate at each cooling coil.
2. Double-wall, 316 stainless-steel sheet.
3. Minimum one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
4. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
5. Width: Entire width of coil.
6. Depth: A minimum of 2 inches deep.
7. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan on the accessible side of the unit.
8. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.5 MARINE LIGHTS

A. LED enclosed and gasketed fixture in each plenum section, access section, mixing box, fan, and section.

B. Aluminum die cast housing with polycarbonate lens.

C. All lights wired to single switch external switch.

D. LED lights with minimum 50,000-hour life.

E. 120-volt, one phase electrical service separate from unit fan motors and convenience outlet service.

2.6 FAN, DRIVE, AND MOTOR

A. Direct-Driven Supply-Air Fans: Double width, backward inclined, SWSI plenum fan; with permanently lubricated, motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls. Statically and dynamically balanced, solid steel fan shaft, fan wheels keyed to fan shaft to prevent slipping.

B. Fan sections containing multiple fans shall be controlled from a common control signal.

C. Return/Relief-Air Fan: Backward inclined, SWSI plenum fan, shaft mounted on permanently lubricated motor. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls. Statically and dynamically balanced, solid steel fan shaft, fan wheels keyed to fan shaft to prevent slipping.

D. Furnish unit fans and motor assembly to be internally isolated from unit casing with 2-inch deflection spring isolators.

E. 1.5 service factor. Drives shall be selected at a minimum of 50 percent larger than the motor horsepower.

F. Fan Motor: Comply with requirements in Section 230513.

G. Airflow measurement system, +/-5 percent total accuracy, capable of measuring fan airflow directly to be furnished for unit supply and return/relief fans.

H. Plenum fans to be furnished with expanded metal guard screen for access door, mounted on the door opening.

I. Motors shall be compatible with variable frequency drives. Inverter test shall be performed to check fan vibration levels from 30 to 100 percent of the required operating rpm.

J. Multiple supply fans and multiple return/relief fans shall be furnished with fan isolation dampers.

2.7 COILS

A. General Requirements for Coils:

1. Comply with AHRI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Refer to Drawings for coil capacities and arrangement in unit.
4. Coils shall not act as structural component of unit.
5. Water Coils: Drainable coil fabricated according to AHRI 410.
6. Piping Connections: On same end.

B. Supply-Air Chilled Water-Cooling Coil:

1. Aluminum-plate fin and seamless copper tube sized at 500 FPM maximum face velocity. Vent and drain connection. Rows scheduled on drawings are minimum. Fins scheduled on drawings are maximum. Coil performance certified in accordance with AHRI 410. Coils burst tested to 300 psig and leak tested to 200 psig.

C. Supply-Air Heating Hot Water Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing sized at 600 FPM maximum face velocity. Vent and drain connection. Rows scheduled on drawings are minimum. Fins scheduled on drawings are maximum. Coil performance certified in accordance with AHRI 410. Coils burst tested to 300 psig and leak tested to 200 psig.

D. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor. Sized at 500 FPM maximum. Coils proof tested to 450 psig and leak tested to 300 psig. Suction headers shall be constructed of copper tubing with connection penetrating unit casing to permit sweat connection to refrigerant

lines. The coils shall have equalizing vertical distributors sized according to the capacities of the coils. Coil performance certified in accordance with AHRI 410.

2. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1

2.8 SOUND ATTENUATOR

A. Three foot minimum, 22-gauge galvanized steel outer shell. Silencer ratings in accordance with ASTM E 477. Acoustic ratings include dynamic insertion loss and self-noise power levels for both forward and reverse flow.

2.9 REFRIGERANT CIRCUIT COMPONENTS

A. Refrigeration Specialties:

1. Refrigerant: R-32, R-410A, R452b, R-454b, or R-466A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.

2.10 AIR FILTRATION

A. Minimum air resistance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated: 2-inch thick, Minimum 90 percent air resistance, and MERV 13.
2. Cartridge: 4-inch thick, Minimum 95 percent air resistance, and MERV 13.
3. Factory installed flush mounted, dial type differential pressure gauge with +/-5 percent accuracy.

2.11 DAMPERS

A. Control Dampers: Comply with requirements in Section 233300.

B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Motorized, with bird screen and hood.
3. Outdoor air dampers shall have integral factory mounted airflow measurement station. Provide two (2) outside air dampers minimum in each unit. Size one damper for fixed minimum airflow rate. Size the other damper for economizer operation.

2.12 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.13 CONTROLS

A. Control equipment and sequence of operation are specified in Section 230900. Control devices, control wiring, control panel, and conduit will be field installed.

B. 120-volt electrical service for unit controls to be circuited separately from unit fan motors, convenience outlet, and unit lighting.

2.14 ACCESSORIES

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Outlet shall be energized even if the unit main disconnect is open. Convenience outlet to be powered separately from unit fan motors, unit controls, and unit lighting circuit.

B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

C. Bearings requiring relubrication shall have the grease line extended to the fan support bracket on the drive side of the fan.

2.15 ROOF CURBS

A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

    a. Materials: ASTM C 1071, Type I or II.
    b. Thickness: 2 inches.

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

    a. Liner Adhesive: Comply with ASTM C 916, Type I.
    b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
    c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
    d. Liner Adhesive: Comply with ASTM C 916, Type I.

B. Curb Height: 14 inches.

C. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site.

2.16 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 311, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before RTU installation. Replace with new insulation materials any filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping systems and electrical services to verify actual locations of connections before installation.

D. Examine roofs for suitable conditions where RTUs will be installed.

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

3.2 INSTALLATION

A. Roof Curb: Install on roof structure, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts. "Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200. Secure RTUs to upper curb rail, and secure curb base to roof framing.

B. Install condensate drain, minimum connection size, with trap and indirect connection as denoted on drawings.

C. Install piping adjacent to RTUs to allow service and maintenance.

D. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to terminate at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300.
4. Install return-air duct continuously through roof structure.

3.3 FIELD QUALITY CONTROL

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

B. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.5 DEMONSTRATION AND TRAINING

A. Demonstrate system operations and verify specified performance. Demonstrate low ambient operation during winter testing for air-cooled condensers.

B. Engage a factory-authorized service representative to train CAWCD maintenance personnel to adjust, operate, and maintain air-handling units. Provide an additional follow-up training session six-months after start-up.

END OF SECTION 237413

SECTION 238103 - PACKAGED ROOFTOP AIR CONDITIONING UNITS – SMALL CAPACITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged rooftop air conditioning unit (cooling and heat pump up to 25 tons).
2. Roof curb.

1.2 DEFINITIONS

A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

B. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btuh to total rate of electric input in watts under designated operating conditions.

C. Seasonal Energy Efficiency Ratio (SEER) - Total cooling output of an air conditioner during its normal annual usage period for cooling (in Btu) divided by total electric energy input during the same period (in Wh).

1.3 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit manufacturer literature indicating:

a. Cooling and heating capacities.
b. Dimensions.
c. Weights.
d. Rough-in connections and connection requirements.
e. Duct connections.
f. Electrical requirements with electrical characteristics and connection requirements.
g. Controls.
h. Accessories.

2. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

B. Shop Drawings (SD):

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: Power, signal, and control wiring.
3. Piping connection points, refrigerant piping, and condensate piping.
4. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

1.4 CLOSEOUT SUBMITALS

A. Project Record Documents: Record actual locations of controls installed remotely from units.

A. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data. Include O&M data in final O&M Manuals submitted to CAWCD.

1.5 QUALITY ASSURANCE

A. Cooling Capacity: Rate in accordance with AHRI 210/240 and AHRI 340/360 as required.

B. Sound Rating: Measure in accordance with AHRI 270.

C. Insulation and adhesives: Meet requirements of NFPA 90A.

D. Performance Requirements: Conform to minimum EER (2) and SEER (2) prescribed by ASHRAE 90.1 when tested in accordance with AHRI 210/240 and AHRI 340/360 as required.

E. Comply with latest DOE efficiency standards for unitary equipment.

F. Outside Air Damper Leakage: Test in accordance with AMCA 500.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in designing and manufacturing products specified in this section with a minimum of ten years documented experience, and which publishes equipment product data.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 EXTRA MATERIALS

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

1. Filters.

2. Gaskets.
3. Fan Belts.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Accept units on site. Inspect for damage.

B. Protect units from damage by storing off roof until roof mounting curbs are in place.

1.9 COORDINATION

A. Coordinate installation of roof curbs with roof structure, roof deck and roof membrane installation.

1.10 WARRANTY

A. Furnish 10-year manufacturer's warranty for compressors.

B. Furnish five-year manufacturer's warranty for heat exchangers.

C. Warranty periods shall begin on date of start-up.

PART 2 - PRODUCTS

2.1 ROOFTOP AIR CONDITIONING UNITS

A. Manufacturers:

1. Trane (basis of design)
2. Daikin Applied (upon approval from CAWCD)
3. Carrier Global Corporation (upon approval from CAWCD)

B. Product Description: Self-contained, packaged, factory assembled and wired, consisting of roof curb, cabinet, supply fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, air filters, mixed air casing, controls, and accessories. Heating shall be provided by gas-fired heating section, electric heating coil, or hot water heating coil.

C. Configuration: As indicated on Drawings.

D. Roof Mounting Curb: 14-inch high, galvanized steel, channel frame with gaskets, nailer strips. Full perimeter type for mounting under entire unit.

E. Cabinet:

1. Designed for outdoor installation with weatherproof construction.
2. Panels: Constructed of galvanized steel with baked enamel finish meeting salt spray test in accordance with ASTM B117. Furnish access doors or removable access panels.

3. Insulation: Factory applied to exposed vertical and horizontal panels. One-inch-thick aluminum foil faced glass fiber with edges protected from erosion.

F. Supply Fan: Forward curved centrifugal type, resiliently mounted with direct drive, V-belt drive, adjustable variable pitch motor pulley, or high efficiency motor. Motor permanently lubricated with built-in thermal overload protection.

G. Evaporator Coil: Constructed of copper tubes expanded onto aluminum fins. Galvanized drain pan with piping connection. Factory leak tested under water.

H. Compressor: Hermetically sealed, resiliently mounted with positive lubrication, and internal motor overload protection. Furnish vibration isolators and short cycle protection.

I. Refrigeration circuit: Furnish the following for each circuit: expansion device, filter-drier, suction, discharge, and liquid line service valves with gauge ports, high- and low-pressure safety controls. Dehydrate and factory charge each circuit with oil and refrigerant.

J. Condenser:

1. Coil: Copper tube aluminum or copper fin coil assembly and coil guard. Factory leak tested under water.
2. Condenser Fan: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Motor permanently lubricated with built-in thermal overload protection.

K. Electric Heating Coil:

1. Finned tube heating elements or Helical nickel-chrome resistance wire coil heating elements with refractory ceramic support bushings easily accessible with automatic reset thermal cut-out, built-in magnetic contactors, galvanized steel frame, control circuit transformer and fuse, manual reset thermal cut-out, airflow proving device, pilot duty toggle switch, load fuses. Single source power connection. Number of stages as indicated on Drawings.
2. Controls: Start supply fan before electric elements are energized and continue operating until air temperature reaches minimum setting, with switch for continuous fan operation.

L. Hot Water Heating Coil:

1. Factory mounted or field installed.
2. Coil: Constructed of copper tubes expanded into aluminum fins. Factory leak tested under water.
3. Furnish factory installed piping package with modulating two-way control valve.

M. Air Filters: 2-inch-thick glass fiber disposable media in metal frames. 25 to 30 percent efficiency based on ASHRAE 52.1. Minimum MERV-13.

N. Mixed Air Casing:

1. Outside Air Damper Leakage: Maximum 3.0 cfm per square foot at 1.0 inches wg pressure differential.
2. Outside Air Damper: Manual, for fixed outside air quantity. Furnish rain hood with screen.
3. Outside Air Damper: Remote controlled with damper operator and remote rheostat for adjusting outside air quantity.
4. Outside Air Damper: Automatic, two position spring return. Interlocked to open when supply fan starts. Outside air damper normally closed and return air damper normally open. Furnish rain hood with screen.
5. Economizer: Factory installed fully modulating motorized outside air and return air dampers controlled by differential enthalpy controller with minimum position setting. Outside air damper normally closed and return air damper normally open. Furnish barometric relief damper capable of closing by gravity. Furnish rain hood with screen. Provide economizer components and controls in accordance with ICC IECC.

O. Controls: Comply with requirements specified in Section 230900, Section 230993, and as indicated on drawings. Manufacturers shall provide interface schematics for integration to CAWCD's building automation system and it must by approved by CAWCD.

P. Accessories:

1. Convenience Outlet: Factory installed, 115-volt, 15-amp, GFCI type, internally mounted. Outlet shall be wired separate from main unit power and from a different source to still provide power when unit is locked out.
2. Roof Curb Adaptor Package: Furnish duct support hardware to adapt unit to existing roof curb.
3. Hail Guards: Provide hail guards to protect condenser coil from damage.

2.2 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before RTU installation. Replace with new insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping systems and electrical services to verify actual locations of connections before installation.

D. Examine roofs for suitable conditions where RTUs will be installed.

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

3.2 INSTALLATION

A. Roof Curb: Install on roof structure, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts. "Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200. Secure RTUs to upper curb rail, and secure curb base to roof framing. Connect units to supply and return ductwork with flexible connections.

B. Install condensate piping with trap and route from drain pan to termination point as indicated on drawings.

C. Install piping adjacent to RTUs to allow service and maintenance.

D. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to terminate at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300.
4. Install return-air duct continuously through roof structure.

E. Install components furnished loose for field mounting.

F. Install electrical devices furnished loose for field mounting.

G. Install control wiring between unit and field installed accessories.

H. Locate remote panels as indicated on Drawings.

3.3 INSTALLATION - HOT WATER HEATING COIL

A. Make connections to coils with unions or flanges.

B. Connect water supply to leaving airside of coil (counter flow arrangement).

C. Locate water supply at bottom of supply header and return water connection at top.

D. Install water coils to allow draining and install drain connection at low points.

E. Install the following piping accessories on hot water piping connections.

1. On supply:

a. Thermometer well and thermometer.
b. Well for control system temperature sensor.
c. Shutoff valve.
d. Strainer.
e. Control valve.
f. Pressure gage.

2. On return:

a. Thermometer well and thermometer.
b. Well for control system temperature sensor.
c. Pressure gage.
d. Shutoff valve.
e. Balancing valve.

3.4 FIELD QUALITY CONTROL

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

B. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 Prepare test and inspection reports.

3.6 CLEANING

A. Vacuum clean coils and inside of unit cabinet.

B. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.7 DEMONSTRATION AND TRAINING

A. Demonstrate unit operation and maintenance.

B. Engage a factory-authorized representative for one 8 hour day to train CAWCD personnel in operation and maintenance of units. Schedule training with CAWCD, provide at least 14 days' notice to Project Manager of training date.

END OF SECTION 238103

SECTION 238123 - COMPUTER-ROOM AIR CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes air conditioning units, controls, and control panels.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit manufacturer’s literature for 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.
2. Manufacturer's Installation Instructions: Submit procedures for rigging and making service connections.

B. Shop Drawings (SD):

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: Power, signal, and control wiring.
3. Piping connection points, including chilled water, refrigerant piping, and condensate piping.
4. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.4 QUALITY ASSURANCE

A. Performance Requirements: Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with AHRI 210/240 and AHRI 340/360 as required.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in designing and manufacturing products specified in this section with a minimum of five years documented experience, and which publishes equipment product data.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept computer room units on site in factory packing. Inspect for damage.

B. Protect units from damage by storing away from computer room and protected from weather until floor and ceiling are installed.

1.7 EXTRA MATERIALS

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

1. Filters for each unit.
2. Fan Belts for each unit.

1.8 WARRANTY

A. Furnish 10-year manufacturer's warranty for refrigeration compressors. Warranty period shall begin on date of start-up.

PART 2 - PRODUCTS

2.1 FLOOR MOUNTED AIR CONDITIONING UNITS

A. Manufacturers:

1. Compu-Aire, Inc.
2. Liebert; Vertiv Holdings Co.
3. HUNTAIR; A Nortek Air Solutions Company.

B. Product Description: Packaged, factory assembled, pre-wired and pre-piped unit, consisting of cabinet, fans filters, humidifier and controls, reheat and heating coils.

C. Assembly: Up-flow or Down-flow air delivery, in draw-through or blow-through configuration.

D. Cabinet and Frame:

1. Structural Frame: Welded steel suitably braced for rigidity, capable of supporting compressors and other mechanical equipment and fittings with welded tubular steel floor stand with adjustable legs and vibration isolation pads.

2. Doors and Access Panels: Galvanized steel with polyurethane gaskets, hinges to allow removal of panels, and concealed fastening devices.
3. Insulation: Thermally and acoustically line cabinet interior with 1 inch thick acoustic duct liner.
4. Finish of Exterior Surfaces: Baked-on textured vinyl enamel; to match computer equipment.

E. Evaporator Fans and Motors:

1. Fans: Double inlet, forward curved centrifugal fans, statically and dynamically balanced, on steel shaft with self-aligning permanently lubricated ball bearings and V-belt or direct drive.
2. Motor: Drip proof, permanently lubricated ball bearing motor with built-in current and overload protection.
3. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed, variable and adjustable pitch motor sheave, minimum of two matched belts, drive rated minimum 2.0 times nameplate rating of motor.

F. Compressors:

1. Type: Hermetic with resilient suspension system, oil strainer, crankcase sight glass, internal motor protection, low pressure switch, manual reset high pressure switch.
2. Compressors: Individually serviceable without dismantling other components or removing unit from service.
3. Refrigeration Circuits: Two, each with hot gas mufflers, thermal expansion valve with external equalizer, liquid line solenoid valve, liquid line filter-drier, refrigerant sight glass with moisture indicator, service shut-off valves and charging valves and accumulator sized for liquid seal under light load.

G. Evaporator Coils:

1. Alternate row or Split face circuits, direct expansion cooling coils of seamless copper tubes expanded into aluminum fins in A-frame configuration or in vertical flat face configuration.
2. Mount coil assembly in stainless steel drain pan.

H. Condensers:
1. Water or Glycol Cooled: Shell and tube type ASME Section VIII or Coaxial tube in tube type with liquid line stop valve and head pressure actuated water regulating valve. Terminate outside cabinet for easy external connections.
2. Air Cooled: Corrosion resistant cabinet, copper tube aluminum fin coils arranged for two circuits, multiple direct drive propeller fans with permanently lubricated ball bearing single phase motors with internal overload protection. Furnish capacity control by cycling fans.

I. Coil:

1. Seamless copper tubes expanded into aluminum fins with two-way modulating control valve, strainer, and float and thermostatic trap.

J. Filters:

1. Media: Pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded wire grid; enclosed in cardboard frame; 2-inch nominal thickness.
2. Rating, ASHRAE 52.1:

    a. Dust spot efficiency: 25-30 percent.
    b. Weight arrestance: 90-92 percent.
    c. Initial resistance at 500 fpm face velocity: 0.30-inch wg
    d. Recommended final resistance: 1.0-inch wg

K. Refrigerant Reheat Coil:

1. Hot gas refrigerant coil of seamless copper tubes expanded into aluminum fins with three-way solenoid valve on first stage refrigerant circuit.

L. Reheat/heating Coils:

1. Heating Coils: Enclosed fin electrical elements arranged for minimum of two stages.
2. Circuit Protection: Primary and secondary thermal cutouts, differential air pressure switch, and manual reset overload protection and branch circuit overcurrent protection.

M. Humidifier:

1. Infrared Type: High intensity quartz lamps mounted above stainless steel evaporator pan, serviceable without disconnecting water, drain, or electrical connections; pre-piped and utilizing condensate water from cooling coils with stainless steel or brass float valve mechanism; located in bypass air stream; with flush cycle timer and solenoid drain valve.
2. Evaporative Pan Type: Stainless steel pan and cover, serviceable without disconnecting water, drain, or electrical connections; pre-piped with stainless steel or brass float valve mechanism; electric heating coil and low water cut-off switch; with flush cycle timer and solenoid drain valve.
3. Electrode Steam Type:

    a. Type: Self-contained replaceable cylinder, microprocessor-controlled electrode steam generating unit.
    b. Cylinders: Disposable or Cleanable, polypropylene plastic with field adjustable steel electrodes.
    c. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure reducing and flow regulating orifice, and drain with integral air gap on drain.
    d. Cabinet: Steel, 16 gage with enamel finish, with hinged and lockable access door.
    e. Control: Fully modulating control for gradual 0 to 100 percent capacity with field adjustable maximum capacity; high water probe.
    f. Drain Cycle: Field adjustable drain duration and drain interval.
    g. Steam Distributor: Stainless steel steam dispersion tube.

N. Remote Glycol Cooler:

1. Corrosion resistant aluminum cabinet with copper tube aluminum fin coils and multiple direct drive propeller fans with fan guard and permanently lubricated ball bearing single-phase motors with internal overload protection. Furnish capacity control by cycling fans.

O. Glycol Pump Package:

1. Cabinet: Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame.
2. Pumps: Centrifugal pumps with mechanical seal.
3. Controls: Electrical control cabinet with starters, disconnect, lead/lag switch, and automatic switchover and alarm light.
4. Piping: Interconnecting piping, from suction to discharge with shut-off valves, flow switches, check valves in pump discharge, unions, and pressurized expansion tank with air purge vent and system charging connection.

P. Control Cabinet: NEMA 250; Type 2 enclosure, UL listed, with piano hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control circuit transformer.

Q. Disconnect Switch: Non-automatic molded case circuit breaker with handle accessible with panel closed and capable of preventing access until switched to "off" position.

R. Electronic Control System:

1. Solid state with start button, stop button, temporary loss of power indicator, manual reset circuit breakers, temperature control humidity control, and monitor panel.
2. Monitor Panel: Back lighted with no visible indicator lights until operating function is activated; indicators include cooling, humidification, loss of air flow, change filters, high temperature, low temperature, high humidity, low humidity, high head pressure (each compressor), and low suction pressure (each compressor).
3. Temperature and Humidity Control Modules: Solid state plug-in with adjustable set point, "push-to-test" calibration check button, and built-in visual indicators to indicate mode of operation.
4. Location: Through hinged door in front of unit; isolated from conditioned air stream to allow service while system is operating.

S. Microprocessor Control System:

1. Logic Circuitry: Microprocessor continuously monitors operation of process cooling system; continuously displays room temperature and room relative humidity; sounds alarm on system malfunction and simultaneously displays problem. When more than one malfunction occurs, display fault in sequence with room temperature, capability of remembering alarm even when malfunction is cleared, and continue to display fault until reset.
2. Malfunctions:

a. Power Loss.
b. Loss of Air Flow.
c. Clogged Air Filter.
d. High Room Temperature.
e. Low Room Temperature.

f. High Humidity.
g. Low Humidity.
h. Smoke/Fire.
i. Compressor Overload.
j. Compressor Low Pressure.
k. Compressor High Pressure.
l. Supply Fan Overload.

3. Light Emitting Diodes Display: Control Power On, System On, Humidification, De-humidification taking place, Compressor No. 1 operating, Compressor No. 2 operating, Heat or Reheat operating, Economy Cooling.
4. Push Buttons: To STOP process cooling system, START process cooling system, SILENCE audible alarm, push-to-test LED indicators, and display room relative humidity.
5. Remote Signaling: Furnish termination for remote signaling of system status and alarms.

2.2 CEILING MOUNTED AIR CONDITIONING UNITS

A. Manufacturers:

1. Compu-Aire, Inc.
2. Liebert; Vertiv Holdings Co.
3. HUNTAIR; A Nortek Air Solutions Company.

B. Product Description: Self-contained, factory assembled, pre-wired and pre-piped unit, consisting of cabinet, fan, filters, humidifier, controls.

C. Assembly: For horizontal ceiling mounting to fit 24 x 48 inches T-bar ceiling opening.

D. Cabinet: Welded steel with baked enamel finish and lined with 1/2-inch-thick acoustic duct liner.

E. Evaporator Fan: Forward curved centrifugal, directly driven by two-speed motor.

F. Compressor: Hermetic with resilient suspension system, oil strainer, internal motor overload protection, low pressure switch, manual reset high-pressure switch.

G. Evaporator Coil: Direct expansion cooling coil of seamless copper tubes expanded into aluminum fins, with thermal expansion valve with external equalizer, liquid line filter-drier, service shut-off valves and charging valves. Mount coil assembly in stainless steel drain pan.

H. Water or Glycol Cooled Condenser: Coaxial counter flow tube-in-tube type with liquid line stop valve and head pressure actuated water regulating valve, sized for rated capacity as indicated on drawings.

I. Air Cooled Condenser: Integral copper tube aluminum fin coil sized for rated capacity at 95 degrees F with fan driven by double shafted evaporator fan motor.

J. Remote Air-Cooled Condenser: Integral copper tube aluminum fin coil sized for rated capacity at 95 degrees F with remote fan package.

K. Filter: 1-inch-thick disposable glass fiber media.

L. Heating Coils: Nichrome wire electric elements with contactor, dehumidification relay, and high temperature limit switch.

M. Atomizing Humidifier: Centrifugal atomizer with stainless steel pan, demister pad, and solenoid valve.

N. Evaporative Pan Type: Stainless steel pan and cover, with stainless steel or brass float valve mechanism, electric heating coil with low water cut-off switch, flush cycle timer and solenoid drain valve.

O. Electrode Steam Type: Self-contained type with replaceable cylinder, microprocessor controlled.

P. Remote Glycol Cooler:

1. Cooler: Corrosion resistant cabinet with copper tube aluminum fin coil, direct drive propeller fan with fan guards and permanently lubricated ball bearing, multiple speed, single phase fan motors with internal overload protection.
2. Pump: In-line type centrifugal pump with mechanical seal.
3. Controls: Electrical control cabinet with starters, relays, and disconnects.
4. Piping: Interconnecting piping, from suction to discharge with shut-off valves, flow switch, check valve in pump discharge and unions.
5. Glycol: Inhibited ethylene or propylene glycol and water solution mixed suitable for operation temperature of -40 degrees F.
6. Expansion Tank: Diaphragm expansion tank and vent fitting with air separator, automatic air vent, and system charging connection.

Q. Remote Air-Cooled Condenser: Corrosion resistant cabinet, copper tube aluminum fin coils arranged for two circuits, multiple direct drive propeller fans with permanently lubricated ball bearing single phase motors with internal overload protection. Furnish capacity control by cycling fans.

R. Control System:

1. Unit Mounted: Main fan contactor, compressor and condenser fan contactor, compressor start capacitor, controls transformer with circuit breaker, solid state temperature and humidity control modules, humidity contactor, time delay relay, reheat contactor, and high temperature thermostat.
2. Solid state wall or unit mounted with start/stop switch, adjustable humidity setpoint, and adjustable temperature setpoint.

2.3 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Disconnect Switch: Factory mount in control panel or on equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems and electrical services to verify actual locations of connections before installation.

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

D. Verify computer-flooring system is ready to receive work and opening dimensions are as indicated on shop drawings.

E. Verify ceiling system is ready to receive work and opening dimensions are as indicated on shop drawings.

3.2 INSTALLATION

A. Coordinate installation of computer room air conditioning units with computer room raised floor.

B. Coordinate installation of air conditioning unit with computer room ceiling.

C. Install the following piping accessories on condenser and chilled water piping connections.

1. On inlet:

    a. Thermometer well and thermometer.
    b. Strainer.
    c. Flow switch.
    d. Flexible pipe connection.
    e. Pressure gage.
    f. Shut-off valve.

2. On outlet:

    a. Thermometer well and thermometer.
    b. Flexible pipe connection.
    c. Pressure gage.
    d. Balancing valve.

D. Install drainage piping connections for water cooled units, condensate, and humidifier flushing system.

E. Install hot water heating piping connections to reheat coils. Install shut-off valves in hot water heating inlet and outlet piping.

F. Install steam piping connections to steam heating coils. Install shut-off valves in steam supply piping and in condensate outlet piping. Install steam trap in condensate outlet piping.

G. Install refrigerant piping connections to air-cooled condensing units.

H. Install accessories furnished loose for field mounting.

I. Install electrical devices furnished loose for field mounting.

J. Install control wiring between control panel and field mounted control devices.

K. Provide connection to electrical service.

3.3 FIELD QUALITY CONTROL

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

B. Tests and Inspections:

1. After installing units and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

E. After start-up service and performance test, change filters and flush humidifiers.

3.4 ADJUSTING

A. Furnish services of factory trained representative for minimum of one day to start-up, calibrate controls, and instruct Owner on operation and maintenance.

B. Set initial temperature and humidity set points.

3.5 DEMONSTRATION

A. Demonstrate system operations and verify specified performance. Demonstrate alarm conditions.

B. Engage a factory-authorized service representative to train CAWCD maintenance personnel to adjust, operate, and maintain air-handling units. Provide an additional follow up training session six-months after start-up.

END OF SECTION 238123

SECTION 238126 - SPLIT-SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

A. Product Data (PD):

1. Submit manufacturer’s literature for 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 (SD):

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: Power, signal, and control wiring.
3. Piping connection points, including refrigerant piping and condensate piping.
4. Submit a model in PDF file format, drawn to scale, showing piping systems, including equipment, hangers, critical dimensions, critical elevations, valve locations, and sizes. Include coordination components such as ductwork, electrical conduits, fire sprinkler piping, and structural components that may affect pipe routing.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data: Include instructions for inspection, maintenance, lubrication, filter replacement, motor and drive replacement, adjustments, spare parts lists, and wiring diagrams. Include O&M data in final O&M Manuals submitted to CAWCD.

1.4 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/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in designing and manufacturing products specified in this section with a minimum of ten years documented experience, and which publishes equipment product data.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 EXTRA MATERIALS

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

1. Filters.
2. Gaskets.
3. Fan Belts.

1.7 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 start-up.
b. For Parts: One year from date of start-up.
c. For Labor: One year from date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: (Alternatives only accepted with prior approval from CAWCD)

1. Basis of Design: Daikin
2. Mitsubishi Electric & Electronics USA, Inc.
3. Samsung HVAC

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with AHRI 210/240.
4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm); leak tested to 300 psig (2070 kPa) underwater; with a two-position control valve.
5. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
7. Fan Motors:

    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513.
    b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
    c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
9. Filters: MERV-13 unless noted otherwise.
10. Condensate Drain Pans:

    a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
        1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
        2) Depth: A minimum of 2 inches (50 mm) deep.

    b. Insulated single-wall, galvanized-steel sheet or polystyrene.
    c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
    d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
    e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

    a. Compressor Type: Scroll.
    b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
    c. Refrigerant Charge: R-410A.
    d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with AHRI 210/240.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 0 deg F.
7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 230900 and Section 230993.

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

    1. Compressor time delay.
    2. 24-hour time control of system stop and start.
    3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
    4. Fan-speed selection including auto setting.

D. Automatic-reset timer to prevent rapid cycling of compressor.

E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

F. Drain Hose: For condensate.

2.5 ECONOMIZER MIXING BOX (5 TONS OR GREATER)

1. Mixing Box: Field installed fully modulating motorized outside air and return air dampers controlled by adjustable dry bulb controller with minimum position setting. Outside air damper normally closed and return air damper normally open. Relief air during economizer mode shall be provided by a relief hood with gravity back-draft damper. Provide economizer components and controls in accordance with ICC IECC C403.5.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 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.

C. Duct Connections: Duct installation requirements are specified in Section 233113. Drawings indicate the general arrangement of ducts. Connect supply ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300.

3.3 FIELD QUALITY CONTROL

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

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 DEMONSTRATION AND TRAINING

A. Demonstrate system operations and verify specified performance.

B. Engage a factory-authorized service representative to train CAWCD maintenance personnel to adjust, operate, and maintain split system units.

END OF SECTION 238126

SECTION 280800 - COMMISSIONING OF FIRE ALARM

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Cx process requirements for the following fire alarm systems, assemblies, and equipment:

1. Digital, Addressable Fire Alarm Systems.

1.2 COMMISSIONING DESCRIPTION

A. Fire Alarm commissioning process includes the following tasks:

1. Testing and startup of fire alarm equipment and systems.
2. Equipment and system verification checks.
3. Assistance in functional performance testing to verify equipment and system performance.
4. Provide qualified personnel to assist in commissioning tests.
5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
7. Provide operation and maintenance information, list of PM tasks, recommended frequency, any instructions or diagrams needed to do the maintenance task, and record drawings to Commissioning Authority for review verification and organization, prior to distribution. Provide a detailed list of any spare parts, consumables, or special tools that may be needed for long-term maintenance.
8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
9. Provide training for systems specified in this Section with coordination by Commissioning Authority.

B. Equipment and Systems to Be Commissioned:

1. New fire alarm systems that were installed under this Contract.
2. Existing fire alarm systems that were modified, adjusted, upgraded, or affected by the work performed under this Contract.

C. The following is a partial list of equipment that may be included in this fire alarm Commissioning:

1. Manual pull stations.
2. Smoke detectors.
3. Duct smoke detectors.
4. Notification devices.
5. Heat detectors.

6. Fire alarm panel.
7. Batteries.
8. Tamper switches.
9. All other initiating devices, notification devices, and controllers.
10. Honeywell ONYXWorks point of control workstation.

1.3 SUBMITTALS

A. Draft Forms: Submit draft of system verification form and functional performance test checklist tailored to the project specifics of this contract.

B. Certificate of Readiness: Signed by the contractor, certifying that the plumbing systems, assemblies, equipment, and associated controls are ready for testing.

C. Commissioning Reports:

1. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified. Use NFPA forms as guidelines.
2. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.

D. Certificate of Completion: Certifying that the installation, prestart checklists, and startup procedures on all equipment in scope has been completed.

E. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning. Commissioning Authority is to work with contractors on the installation progress and is ultimately responsible for ensuring that the Contractor has accurately updated Record Documents to as built conditions. Commissioning Authority shall notify CAWCD in the event commissioning necessitates changes in the project record drawings.

F. Operation and Maintenance Data: Commissioning Authority to work with Contractor and provide final Fire Alarm Commissioning package with the final O&M Documents submitted to CAWCD. Provide a list of any ‘as left’ setpoints and other similar metrics if they aren’t already provided elsewhere or in the OEM manuals.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ACG, ASHRAE Guideline 1, NEBB, or TABB requirements. Forms to be approved by engineer.

1.5 QUALIFICATIONS

A. Commissioning Authority: A certified Commissioning Authority (CxA) by the AABC Commissioning Group (ACG) or approved by CAWCD.

B. CAWCD may act as their own Commissioning Authority.

1.6 COMMISSIONING RESPONSIBILITIES

A. General Contractor Commissioning Responsibilities

1. Retain services for an independent qualified 3rd party Commissioning Authority. CAWCD to provide approval of Commissioning Agency selected prior to GMP. CAWCD retains the right to hire the 3rd party Commissioning Authority.
2. Provide CAWCD a schedule of commissioning activities and meetings including (but not limited to) the items outlined in Article 1.8.
3. Delivery of plans, submittals, system manuals, and any other equipment-related information for the Commissioning Authority to review prior to field commissioning.

B. Equipment or System Installer Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Ensure controls installer performs assigned commissioning responsibilities as specified below.
3. Provide instructions and demonstrations for CAWCD's personnel.
4. Ensure subcontractors perform assigned commissioning responsibilities.
5. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
6. Develop startup and initial checkout plan using manufacturer’s startup procedures and functional performance checklists for equipment and systems to be commissioned.
7. During verification check and startup process, execute electrical related portions of checklists for equipment and systems to be commissioned.
8. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
9. Provide manufacturer’s representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.
10. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
11. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
12. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
13. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
14. Provide factory supervised startup services for equipment and systems. Coordinate work with manufacturer and Commissioning Authority.
15. Perform verification checks and startup on equipment and systems as specified.
16. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
17. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
18. Conduct fire alarm system orientation and inspection.

1.7 COMMISSIONING MEETINGS

A. Coordinate all commissioning meetings and progress commissioning meetings with the General Contractor, Fire Alarm Contractor, Commissioning Authority, and CAWCD.

1.8 SCHEDULING

A. Commissioning Authority shall attend pre-installation meetings prior to any fire alarm work being performed. Contractor shall have Commissioning Authority under contract prior to any fire alarm installations.

1.9 COORDINATION

A. Notify CAWCD Project Engineer and Project Manager a minimum of four weeks in advance of the following:

1. Scheduled equipment and system startups.
2. Scheduled fire alarm panel checkout.

B. Coordinate programming of fire alarm control system with construction and commissioning schedules.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Perform Cx process for fire-alarm system in accordance with NFPA 3.

3.2 TESTING PREPARATION

A. Final Commissioning is not to take place unit ONYXWorks programming is completed including, but not limited to, all final graphics, and control points in the software. Software screens, programming layout, etc. to be completed and signed off by CAWCD prior to start of any commissioning. Contractor shall factor this time in the project schedule as to avoid delays in commissioning.

B. Certify that fire-alarm systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

C. Certify that fire-alarm system instrumentation and control systems have been completed and calibrated, that they are operating in accordance with the Contract Documents and approved submittals, and that pretest set points have been recorded.

D. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures.

3.3 INSTALLATION

A. Place fire alarm systems and equipment into full operation and continue operation during each working day of commissioning.

B. Install replacement equipment, devices, and accessories to obtain system performance, as requested by Commissioning Authority.

3.4 FIELD TESTS AND INSPECTIONS

A. Be responsible to participate in initial test of systems required to demonstrate performance.

END OF SECTION 280800

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This section Includes:

1. Existing fire-alarm system to be modified.
2. Addressable fire-alarm system.
3. Fire-Alarm Control Unit
4. Manual Fire-Alarm Boxes
5. System Smoke Detectors
6. Notification Appliances
7. Remote Annunciator
8. Smoke Control Panel
9. Addressable Interface Device

1.2 ACTION SUBMITTALS

A. Product Submittal Requirements:

B. Product Data (PD):

1. For each type of product indicated submit manufacturer's data including all furnished options and accessories.

a. Include construction details, material descriptions, dimensions, profiles, and finishes.
b. Include rated capacities, operating characteristics, and electrical characteristics.

C. Shop Drawings (SD):

1. Provide fire alarm shop drawings showing floor plan device layout, battery calculations, voltage drop calculations, and additional items as required in applicable codes, designed by the Contractor, and reviewed, signed, and sealed by a qualified Fire Protection Engineer registered in the State of Arizona.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
3. ONYXWorks programming graphics shall be submitted prior to any commissioning activities. CAWCD to approve all software screens and graphics prior to final programming and commissioning.

D. Operation and Maintenance Data:

1. Provide operation and maintenance manuals for fire-alarm systems and components.

a. Comply with the “Inspection, Testing and Maintenance" Chapter in NFPA 72.
b. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Inspection, Testing and Maintenance" Chapter.
c. Record copy of site-specific software and any passwords.
d. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name.
e. Provide the frequency of testing of installed components.
f. Provide the frequency of inspection of installed components.
g. Requirements and recommendations related to results of maintenance.
h. Manufacturer's user manuals.
i. Manufacturer's required maintenance related to system warranty requirements.
j. Abbreviated operating instructions for mounting at fire-alarm control unit.

2. Software and Firmware Operational Documentation:
3. Software operating and upgrade manuals.

a. List of all software licenses provided as well as dates the software licenses expire. Provide to CAWCD for renewal.
b. Program Software Backup: On magnetic media or compact disk, complete with data files.
c. Device address list.
d. Printout of software application and graphic screens.

E. Submittals Installer Data: Documentation provided shall indicate the following qualifications:

1. Trained and certified by manufacturer in fire-alarm system design.
2. NICET-certified fire-alarm technician, Level II minimum.

1.3 QUALITY ASSURANCE

A. Installer Qualifications:

1. Personnel shall be trained and certified by manufacturer for installation of units required for this project.
2. Installation shall be by personnel certified by NICET as fire-alarm Level II technician.
3. The fire alarm system contractor shall maintain a fully staffed branch office including application engineers, drafters, and technical service personnel within the Phoenix area.
4. All electrical installation of the fire alarm system, including wire terminations, shall be performed by the technicians in the employ of the installing fire alarm system contractor.
5. All conduit installation of the fire alarm system, including conduit installations, shall be performed by the electricians in the employ of the installing electrical contractor.

B. Installation Requirements:

1. Construction drawings are provided for the fire-alarm and smoke control system. These plans include plans, elevations, sectional drawings, details, and attachments to other work.
2. The installation shall comply with requirements in "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
3. The installation shall comply with the design voltage drop calculations for notification appliance circuits.
4. The installation shall comply with the design battery-size calculations.
5. The installation shall comply with performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
6. The installation shall comply with plans, sectional drawings, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators shall be followed according to manufacturer's written recommendations.
7. The installation shall comply with the designed alarm signaling-service equipment layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
8. The installation shall comply with the designed floor plans to indicate final outlet locations showing address of each addressable device; including size and route of cable and conduits.
9. The installation shall comply with performance requirements for all devices and comply with and design criteria, including analysis data provided.
10. The drawings show the location of each smoke detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.

1.4 FIELD CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by CAWCD or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify CAWCD no fewer than two (2) days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without CAWCD's written permission.

1.5 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service. Label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

1.6 SOFTWARE SERVICE AGREEMENT

A. Comply with UL Standard 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for five years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

D. Software versions must match software versions utilized throughout the rest of the CAWCD system. Otherwise, functionality and communication amongst all the other CAWCD facilities will become an issue. Verify with CAWCD all current software versions on the system prior to bidding and construction. Software versions installed must allow for complete communication across all existing CAWCD facilities.

E. Provide 30 days' notice to CAWCD to allow scheduling and access to system and to allow CAWCD to upgrade computer equipment if necessary.

1.7 WARRANTY

A. Special Warranty: Manufacturer shall provide warranty to repair or replace fire-alarm system equipment and components that fail due to defects in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. The fire alarm and supervisory system shall be a UUKL-listed, addressable system with common alarm, common trouble, and supervisory signaling. The fire alarm system shall be provided with a continuous sounding evacuation signaling system.

B. System circuit wiring:

1. All communication data transmission circuits shall be Style 4, supervised signaling circuits.
2. All fire alarm and supervisory alarm initiating circuits shall be Style A, electrically-supervised circuits from the fire alarm control panel to the devices.
3. All notification appliance circuits shall be Style Y, electrically-supervised circuits from the fire alarm control panel to the devices.
4. All point addressable signaling line circuits shall be Style 4, supervised circuits.
5. All initiating signaling line circuits and notification circuits shall be in rigid galvanized conduit.

2.2 PROJECT DESCRIPTION

A. Provide a new, Notifier, UUKL state-of-the-art intelligent, addressable fire alarm system and smoke control panel, as designed in the specifications and on the construction drawings. The building is to be provided with intelligent, addressable smoke detectors, addressable manual fire alarm stations, addressable duct detectors, strobes, horns, and addressable control and monitoring modules for waterflow switches.

B. A Notifier Gateway panel shall transmit all signals to a CAWCD central office.

2.3 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements: Only the specified product is acceptable.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
2. NOTIFIER; a Honeywell company in accordance with the specifications and drawings.

2.4 EXISTING FIRE-ALARM SYSTEM TO BE MODIFIED

A. Source Limitations for Fire-Alarm System and Components: Components must be compatible with, and operate as extension of, existing system. Provide system manufacturer's certification that components provided have been tested as, and will operate as, a system.

2.5 ADDRESSABLE FIRE-ALARM SYSTEM

A. Description:

1. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/horn-and-strobe notification for evacuation.

B. Performance Criteria:

1. Regulatory Requirements:

a. Fire-Alarm Components, Devices, and Accessories: Listed and labeled by a NRTL in accordance with NFPA 70 for use with selected fire-alarm system and marked for intended location and application.

2. General Characteristics:

a. Automatic sensitivity control of certain smoke detectors.
b. Fire-alarm signal initiation must be by one or more of the following devices and systems:

1) Heat detectors.
2) Manual Stations

3) Flame detectors.
4) Smoke detectors.
5) Duct smoke detectors.
6) Air-sampling smoke-detection system.
7) Carbon monoxide detectors.
8) Combustible gas detectors.
9) Automatic sprinkler system water flow.
10) Pre-action system.
11) Fire-extinguishing system operation.
12) Fire standpipe system.
13) Dry system pressure flow switch.
14) Fire pump running.

c. Fire-alarm signal must initiate the following actions:

1) Continuously operate alarm notification appliances, including voice evacuation notices.
2) Identify alarm and specific initiating device at FACU, connected network control panels, off-premises network control panels, and remote annunciators.
3) Transmit alarm signal to remote alarm receiving station.
4) Unlock electric door locks in designated egress paths.
5) Release fire and smoke doors held open by magnetic door holders.
6) Activate voice/alarm communication system.
7) Switch HVAC equipment controls to fire-alarm mode.
8) Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
9) Activate stairwell and elevator-shaft pressurization systems.
10) Close smoke dampers in air ducts of designated air-conditioning duct systems.
11) Activate pre-action system.
12) Recall elevators to primary or alternate recall floors.
13) Activate elevator power shunt trip.
14) Activate emergency lighting control.
15) Activate emergency shutoffs for gas and fuel supplies, except for shutoffs serving legally required life-safety systems such as emergency generators and fire pumps.
16) Record events in system memory.
17) Record events by system printer.
18) Indicate device in alarm on graphic annunciator.

d. Supervisory signal initiation must be by one or more of the following devices and actions:

1) Valve supervisory switch.
2) High- or low-air-pressure switch of dry-pipe or pre-action sprinkler system.
3) Alert and Action signals of air-sampling detector system.
4) Elevator shunt-trip supervision.
5) Independent fire-detection and -suppression systems.
6) Fire pump is running.

7) Fire pump has lost power.
8) Power to fire pump has phase reversal.
9) Zones or individual devices have been disabled.
10) FACU has lost communication with network.

e. System trouble signal initiation must be by one or more of the following devices and actions:

1) Open circuits, shorts, and grounds in designated circuits.
2) Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3) Loss of communication with addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4) Loss of primary power at FACU.
5) Ground or single break in internal circuits of FACU.
6) Abnormal ac voltage at FACU.
7) Break in standby battery circuitry.
8) Failure of battery charging.
9) Abnormal position of switch at FACU or annunciator.
10) Voice signal amplifier failure.
11) Hose cabinet door open.

f. System Supervisory Signal Actions:

1) Initiate notification appliances.
2) Identify specific device initiating event at FACU, connected network control panels, off-premises network control panels, and remote annunciators.
3) Record event on system printer.
4) After time delay of 200 seconds, transmit trouble or supervisory signal to remote alarm receiving station.
5) Transmit system status to building management system.
6) Display system status on graphic annunciator.

g. Network Communications:

1) Provide network communications for fire-alarm system in accordance with fire-alarm manufacturer's written instructions.
2) Provide network communications pathway per manufacturer's written instructions and requirements in NFPA 72 and NFPA 70.
3) Provide integration gateway using BACnet for connection to building automation system.

h. System Printer:

1) Printer must be listed and labeled as integral part of fire-alarm system.

i. Device Guards:

1) Description: Welded wire mesh of size and shape for manual station, smoke detector, gong, or other device requiring protection.

a) Factory fabricated and furnished by device manufacturer.
b) Finish: Paint of color to match protected device.

j. Document Storage Box:

1) Description: Enclosure to accommodate standard 8-1/2-by-11 inch manuals and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.
2) Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
3) Color: Red powder-coat epoxy finish.
4) Labeling: Permanently screened with 1 inch high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
5) Security: Locked with 3/4 inch barrel lock. Provide solid 12 inch stainless steel piano hinge.

2.6 SYSTEM OPERATIONAL DESCRIPTION

A. Provide a new Notifier, UUKL state-of-the-art intelligent, addressable fire alarm system with addressable smoke detectors, addressable manual fire alarm station(s), addressable duct detectors, strobes, horns, and addressable monitoring modules for workflow switches.

B. Honeywell Notifier system shall include new ONYXWorks UL/FM Global Workstation if called out as such in the project drawings. Latest version to be provided as part of the project.

C. The new addressable fire alarm system shall be capable of providing protection for the entire facility and shall be UUKL Listed. A point addressable control panel shall be located as indicated on the plans. All control panels shall be provided with smoke protection.

D. The new Notifier ONYXWorks system shall be fully programmed and operational allowing full communication to all existing CAWCD facilities. Contractor shall coordinate with CAWCD prior to bidding and construction on existing ONYX versions, software versions, etc. to ensure full communication will work upon final completion. It is the responsibility of the Contractor to ensure this CAWCD-wide communication will take place upon completion. CAWCD can provide backup databases as needed for the rest of the CAWCD network. Coordinate with CAWCD.

E. Fire-alarm signal initiation shall be by one (1) or more of the following devices:

1. Manual stations.
2. Smoke detectors.
3. Duct smoke detectors.
4. Verified automatic alarm operation of smoke detectors.
5. Heat detectors.
6. Automatic sprinkler system water flow.
7. Fire-extinguishing systems operation.

F. System trouble signal initiation shall be by one (1) or more the following actions:

1. Open circuits, shorts, and grounds in designated circuits.

    a. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
    b. Loss of primary power at fire-alarm control unit.
    c. Ground or a single break in fire-alarm control unit internal circuits.
    d. Abnormal ac voltage at fire-alarm control unit.
    e. Break in standby battery circuitry.
    f. Failure of battery charging.
    g. Abnormal position of any switch at fire-alarm control unit or annunciator.
    h. Fire-pump power failure, including a dead-phase or phase-reversal condition.
    i. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system.

G. An alarm signal shall initiate the following actions as required by the Sequence of Operations:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
5. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
6. Activate stairwell pressurization systems.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Recall elevators to primary or alternate recall floors.
9. Record all events in the system memory.

H. A supervisory signal shall initiate the following actions as required by the Sequence of Operations:

1. Identify supervisory signal at fire-alarm control unit and remote annunciators.
2. Transmit a supervisory signal to the remote alarm receiving station.
3. Close smoke dampers in air ducts of designated air-conditioning duct systems.
4. Record all events in the system memory.

I. A trouble signal shall initiate the following actions as required by the Sequence of Operations:

1. Identify trouble signal at fire-alarm control unit and remote annunciators.
2. Transmit a trouble signal to the remote alarm receiving station.
3. Record all events in the system memory.

2.7 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL Standard 864 and UUK Listed and labeled by Underwriter’s Laboratories.
2. The Fire-Alarm Control Unit 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 detectors, addressable modules, annunciators, and other system controlled devices.
3. The central processing unit (CPU) shall be a "mini" or "micro" computer, UL-Listed for fire alarm use. (Use of non UL-Listed computers is strictly forbidden.) The main memory system shall be adequately sized to provide display, printout, and control of 150% of the actual alarm and command points as described herein and indicated on the drawings. All basic alarm and control software shall be included. The CPU shall be completely field programmable and all data entered shall reside in the system.
4. The CPU shall be equipped with a non-volatile main memory system of EPROM, battery protected RAM, bubble type, or EEPROM memory system. The mass storage for all English descriptors, English language operator's messages. The mass storage means shall be equipped with all necessary control hardware.
5. Normal operating power for the FACP shall be a dedicated 120 VAC, single-phase, 60 Hz supplied from the building circuit distribution power panel. Power supply shall be dedicated to the system. Transfer from normal to emergency power or restoration of normal power shall be automatic. In addition, the CPU shall be provided with an emergency battery standby power system, which shall operate the system for 24 hours in the standby mode and 5 minutes in alarm mode.
6. The system-operating terminal (OPT) shall include, at a minimum, control function keys, digital display window programming keys, and key-operated lockout capability. The time shall be permanently displayed on the OPT and shall be visible at all times. The OPT shall allow the operator to perform the following minimum tasks:

B. Serial Interfaces:

1. The system shall include serial EIA-232 interfaces. Each interface shall be a means of connecting UL-Listed Information Technology Equipment (ITE) peripherals.

    a. The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
    b. The EIA-485 interface may be used for network connection to a proprietary-receiving unit.

C. Enclosures:

1. 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.
2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.

3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be site configured for either right or left hand hinging.

D. Addressable initiation devices that communicate device identity and status:

1. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
2. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

E. Addressable control circuits for operation of mechanical equipment.

F. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

G. Annunciator and Display: Liquid-crystal type, of 80 characters, minimum.

H. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

I. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.
2. Initiating Device Circuits: Style A.

    a. Notification Appliance Circuits: Style Y.
    b. Signaling Line Circuits: Style A.
    c. Serial Interfaces: One (1) RS-232 port.

3. All fire alarm wiring shall match the color coding as identified on the drawings.

J. Elevator and Stairwell Pressurization: Provide an output signal using an addressable relay to start the stairwell pressurization system. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.

1. Pressurization starts when any alarm is received at fire-alarm control unit.

K. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an UL-Listed and approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Sound general alarm if the alarm is verified.
4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
5. Notification Appliance Circuit: Operation shall sound in a temporal code.

L. Elevator Recall:

1. Smoke detectors at the elevator lobbies on non-primary floors shall initiate automatic elevator recall to the primary floor.
2. Smoke detector in elevator machine room.
3. The elevator lobby detector located on the primary recall floor shall be programmed to move the cars to the alternate recall floor.

M. Transmission to Remote Alarm Receiving Station:

1. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals through a Notifier Gateway panel to the CAWCD central office.

N. Power:

1. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and network signal communications shall be powered by 24-V dc source.
2. Alarm current draw of entire fire-alarm system shall not exceed 70 percent of the power-supply module rating.
3. Secondary Power: 24-V DC supply system with batteries, automatic battery charger, and automatic transfer switch.
4. Batteries: Sealed lead calcium.

O. Instructions:

1. Manufacturer’s printout or instruction card mounted adjacent to the Fire Alarm Control Panel. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.8 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL Standard 38 and shall be addressable. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation

B. The word FIRE shall appear on the manual station in letters one-half inch in size or larger. Manual fire alarm stations shall be single-action be non-code, non-break glass type, equipped with key lock so that they may be tested without operating the handle. Operation of a manual fire alarm station shall cause its contacts to lock-in until manually reset and visually indicate an actuation (i.e., depressed lever, shattered glass). Each station shall be individually addressed at the central control panel. Stations which rely on wires from auxiliary contacts to the panel, do not meet this requirement.

2.9 SYSTEM SMOKE DETECTORS

A. Photoelectric Smoke Detectors: The smoke detectors shall be provided where indicated on the drawings. Photoelectric smoke detectors shall be provided with integral LEDs to indicate detectors in alarm. The detectors shall operate from the 2-wire alarm initiating circuit and be listed under UL Standard 268. Line transient and RFI protection shall be built into the detector. Mounted concealed detectors shall have a remote indicator light or LED. There shall be provisions for mounting a control relay in the base of the detector.

1. Beam Detectors: The smoke beam detectors shall be provided where indicated on the drawings. Beam smoke detectors shall be provided with integral LED-remote test switch to indicate detector in alarm and provide for test functions. The detectors shall operate from the 2-wire alarm initiating circuit and be listed under UL Standard 268. Line transient and RFI protection shall be built into the detector. Mounted heights shall conform to the manufacturers' specifications.
2. Duct Smoke Detectors - Photoelectric: These detectors shall be provided where indicated on the drawings. Duct-mounted smoke detectors shall be resettable from the fire alarm control panel and be provided with approved duct housings mounted on the exterior of the duct, and shall have perforated sampling tubes extended across the width of the duct. These detectors shall be required for damper actuation in areas not covered by corridor smoke detectors, or where area smoke detection is not provided on one (1) or both sides of the damper. Duct mounted smoke detectors are also required in the supply side of air handlers supplying over 2,000 cfm and on each floor served by more than one (1) unit totaling over 2,000 cfm.
3. Each mounted duct smoke detector shall have a remote indicator light and a remote test and reset switch. Provide programmable relays for fan shutdown and control. Each mounted duct smoke detector shall have a remote indicator light and a remote test and reset switch. Provide programmable relays for fan shutdown and control. General:

B. Each device shall be field set and assigned a unique address. Devices, which take their address from their position in the circuit, are unacceptable because if devices are later added or removed, existing addresses, descriptors, and commands must be reprogrammed.

1. Additional devices must be capable of being added to the circuit from any point in the circuit and without affecting any existing device's address or function.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).
    f. Each sensor shall have multiple levels of detection sensitivity.
    g. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
    h. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.10 NOTIFICATION APPLIANCES

A. Horn units shall be provided for clear, intelligible temporal code heard in all occupied areas and in each dwelling. The units shall be surface mounted in unfinished areas and semi-flush in finished areas. The units shall operate on 24 volts DC (VDC) polarized power to allow for supervision.

B. The visual alarm units shall contain a strobe light source and sturdy translucent lens. Standard finish shall be white with the word “FIRE” imprinted on a clear translucent lens. All visual units shall operate on 24 VDC polarized power to allow for supervision. Visual units shall be in accordance with the ADA and UL Standard 1971. All visual units shall be mounted in accordance with NFPA 72 and ADA.

1. Water and moisture sealed metal housing.
2. Multi-tap selection.
3. Screw terminals for in-out wiring.
4. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL Standard 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL Standard 464 test protocol.
5. Visible Notification Appliances: Xenon strobe lights comply with UL Standard 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.

2.11 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

B. Mounting: Flush cabinet, NEMA 250, Type 1.

C. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.12 SMOKE CONTROL PANEL

A. Box and Frame: The smoke control panel shall be a Kirkland CEF-L-GR model in No. 16 gauge steel with a black textured finish, and semi-flush back box.

B. Door: The door shall be a No.16 gauge stainless steel with a No.4 horizontal brush finish.

C. Hinge: The door shall have a concealed stainless steel hinge located on the left side.

D. Fastener: A No. 2171 Key change lock shall be included.

2.13 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, UL-Listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: The control relays/contacts shall be 24-volt DC low voltage type, each with number of contacts as required and housed in metal enclosure. The contacts shall be rated as required for continuous duty.

1. Power supplies used for operation of control relays, contacts, step-down relays or similar applications shall be supervised by the fire alarm system for trouble conditions.
2. Addressable point control devices shall be used to provide all required control functions. Control devices used for activation of fire suppression systems or similar releasing equipment shall be listed for Releasing Service. Control relays connected to unsupervised circuits shall be located within three (3) feet of the controlled device.
3. Retain one (1) or two (2) transmitter articles below allowing transmission of alarm, supervisory, and trouble signals to a remote alarm receiving station or another remote location.
4. Notifier Gateway Network Communicator shall be provided.
5. The network annunciator shall be a Notifier NAC2 with remote liquid crystal display (LCD) annunciator shall include, at a minimum, control function keys, digital display window, programming keys and key-operated lockout capability. The time shall be permanently displayed on the LCD and shall be visible at all times. The LCD shall be supervised by the network controller, backlit, and display a minimum of two (2) lines with 80 alphanumeric characters. The LCD annunciator shall be equipped with an internal sounder that may silence locally. A remote annunciator shall be located in the security office and main vestibule.
6. Functional Performance: Unit shall receive all point addressable alarm, supervisory, or trouble signals from fire-alarm control unit and automatically via network communication to the CAWCD security station. When contact is made with central station(s), signals shall be transmitted. If service on line is interrupted for longer than 45 seconds, CAWCD security station transmission shall initiate a local trouble signal and transmit the signal indicating loss of network communications to the remote CAWCD security station. Local functions and display at the digital alarm communicator transmitter shall include the following:
7. Secondary Power: Integral rechargeable battery and automatic charger.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.2 PREPARATION

A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.

B. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 EQUIPMENT INSTALLATION

A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before other trades have completed cleanup must be replaced.
2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of building.
2. Connect new equipment to existing monitoring equipment at supervising station.
3. Expand, modify, and supplement existing equipment as necessary to extend existing control/monitoring functions to new points. New components must be capable of merging with existing configuration without degrading performance of either system.

C. Equipment Floor and Wall Mounting: Install FACU on finished floor.

D. Install wall-mounted equipment, with tops of cabinets not more than 78 inch above finished floor.

E. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in normal path of egress within 60 inch of exit doorway.
2. Mount manual fire-alarm box on background of contrasting color.

3. Operable part of manual fire-alarm box must be between 42 and 48 inch above floor level. Devices must be mounted at same height unless otherwise indicated.

F. Smoke- and Heat-Detector Spacing:

1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.

2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.

3. Smooth ceiling spacing must not exceed 30 ft.

4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with Annex A or Annex B in NFPA 72.

5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from lighting fixture and not directly above pendant mounted or indirect lighting.

G. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.

H. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than 36 inches long must be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

I. Air-Sampling Smoke Detectors: If using multiple pipe runs, runs must be pneumatically balanced.

J. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

1. Elevators: work performed on the elevator systems must be done by the State of Arizona Contractor per contract EPS060002-A2-1-A10 or its succeeding contract.

K. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within dwelling or suite, they must be connected so that operation of smoke alarm causes alarm in smoke alarms to sound.

L. Remote Status and Alarm Indicators: Install in visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

M. Audible Alarm-Indicating Devices: Install not less than 6 inch below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.

N. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inch below ceiling. Install devices at same height unless otherwise indicated.

O. Device Location-Indicating Lights: Locate in public space near device they monitor.

P. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists wind load of 100 mph with gust factor of 1.3 without damage.

3.4 PATHWAYS

A. Pathways above recessed ceilings and in inaccessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches above floor must be installed in EMT.

3.5 Exposed EMT must be painted red enamel.

3.6 CONNECTIONS

A. Make addressable connections with a supervised interface device to the following devices and systems. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated HVAC duct systems.
4. Magnetically held-open doors.
5. Electronically locked doors and access gates.
6. Alarm-initiating connection to elevator recall system and components.
7. Alarm-initiating connection to activate emergency lighting control.
8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
9. Supervisory connections at valve supervisory switches.
10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
11. Supervisory connections at elevator shunt-trip breaker.
12. Data communication circuits for connection to building management system.
13. Data communication circuits for connection to mass notification system.
14. Supervisory connections at fire-extinguisher locations.
15. Supervisory connections at fire-pump power failure including dead-phase or phase-reversal condition.
16. Supervisory connections at fire-pump engine control panel.

3.7 IDENTIFICATION

A. Identify and label all system components, wiring, cabling, and terminals.

B. Install framed instructions in a location visible from fire-alarm control unit.

C. Every wire to be labeled at every termination point per the CAWCD drawings. Wire labeling to match shop drawings and/or CAWCD construction drawings. Final approval

will not be made unless every wire is properly labeled and visible. This includes all panels wired and assembled prior to installation

3.8 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with NFPA 70. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.9 FIRE RESISTANCE RATED CONSTRUCTION

A. All penetrations through fire-resistance rated construction (walls, floors, ceilings, etc.) are required to be sealed with UL listed assemblies as required to maintain the integrity of the fire-resistance rating. Contractor is required to submit all proposed UL listed fire-resistance rated assemblies for piping/ductwork penetrations to Engineer for review and approval prior to installation.

3.10 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by CAWCD.

B. Perform tests and inspections.

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

D. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.
    a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Fundamentals of Fire Alarm Systems" Chapter.
    b. Comply with "Visual Inspection Frequencies" Table in the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
2. System Testing: Comply with "Test Methods" Table in the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
3. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
4. Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.11 DEMONSTRATION

A. A factory-authorized service representative shall train CAWCD's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111