PROJECT MANUAL

FOR

Pasco School District
Orion High School

1815 East Salt Lake Street
Pasco, Washington

VOLUME 2: DIVISION 10 – DIVISION 33

December 18, 2023

9354 REGISTERED ARCHITECT
12/18/23
BRANDON D. WILM
STATE OF WASHINGTON

Design West Architects
830 N Columbia Center Blvd, Suite E
Kennewick, WA 99336
509-783-2244

TABLE OF CONTENTS

VOLUME 1: Division 00 – Division 09

VOLUME 2: Division 10 – Division 33

DIVISION 10 – SPECIALTIES

DIVISION 11 – EQUIPMENT

DIVISION 12 – FURNISHINGS

DIVISION 13 – SPECIAL CONSTRUCTION

DIVISION 14 – CONVEYING SYSTEMS

DIVISION 15 through DIVISION 20 – not used

DIVISION 21 – FIRE SUPPRESSION

DIVISION 22 – PLUMBING

DIVISION 10 – SPECIALTIES

SECTION 10 11 16 – MARKERBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Markerboards framed—fixed.
   2. Accessories and support systems for visual display boards.

B. Related Sections include the following:
   1. Division 06 Section "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.
   2. Division 06 Section "Finish Carpentry" for interior carpentry exposed to view that is not specified in this Section.
   3. Division 06 Section "Interior Architectural Woodwork" for casework integration.
   4. Division 10 Section “Visual Display Surfaces” for sliding marker and tackboard applications.
   5. Division 22 Section “Plumbing” for rough-in and coordination of sinks, service fixtures and fittings, supply and waste lines, connections and vents incorporated into casework.
   6. Division 23 Section “HVAC” for coordination of ductwork and vents incorporated into casework.
   7. Division 26 Section “Electrical” for rough-in and coordination of electrical, phone, data outlets, J-boxes, conduit, fittings and cabinet lighting and controls incorporated into casework.

1.2 DEFINITIONS

A. Visual Display Board Assembly: Visual display surface that is factory fabricated into composite panel form, either with or without a perimeter frame; includes markerboards.

B. Visual Display Surface: Surfaces that are used to convey information visually, including surfaces of markerboards and surfacing materials that are not fabricated into composite panel form but are applied directly to walls.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for visual display surfaces.

B. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.
   1. Show locations of panel joints.
   2. Show locations of special-purpose graphics for visual display surfaces.
   3. Include sections of typical trim members.

C. Samples for Verification: For each type of visual display surface indicated.
   1. Visual Display Surface: Not less than 8-1/2 by 11 inches, mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
   2. Trim: 6-inch- long sections of each trim profile.
   3. Accessories: Full-size Sample of each type of accessory.

D. Product Schedule: For visual display surfaces. Use same designations indicated on Drawings.

E. Qualification Data: For qualified Installer.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.

G. Operation and Maintenance Data: For visual display surfaces to include in maintenance manuals.

H. Warranties: Sample of special warranties.

I. WSSP Submittals: Not Used.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of motor-operated, sliding visual display units required for this Project.

B. Source Limitations: Obtain visual display surfaces from single source from single manufacturer.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 450 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-built visual display surfaces, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.

B. Store visual display surfaces vertically with packing materials between each unit.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install visual display surfaces until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Field Measurements: Verify actual dimensions of construction contiguous with visual display surfaces by field measurements before fabrication.
   1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.7 WARRANTY

A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Surfaces lose original writing and erasing qualities.
      b. Surfaces exhibit crazing, cracking, or flaking.
   2. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Porcelain-Enamel Face Sheet: Manufacturer's standard steel sheet with porcelain-enamel coating fused to steel.
   1. Gloss Finish: Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser.

B. Melamine: Thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.

C. High-Pressure Plastic Laminate: NEMA LD 3.

D. Natural Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish

E. Plastic-Impregnated Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout.

F. Vinyl Fabric: Mildew resistant, washable, complying with FS CCC-W-408D, Type II, burlap weave; weighing not less than 13 oz./sq. yd.; with surface-burning characteristics indicated.

G. Hardboard: ANSI A135.4, tempered.

H. Particleboard: ANSI A208.1, Grade M-1, made with binder containing no urea formaldehyde.

I. Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.

J. Extruded Aluminum: ASTM B 221, Alloy 6063.

K. Adhesive: Mildew-resistant, nonstaining adhesive, for use with specific tack wall panels and substrate application, as recommended in writing by visual display surface manufacturer, and

with a VOC content of **50** g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.2 MARKERBOARD ASSEMBLIES

A. Porcelain-Enamel Markerboards: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of backing sheet, core material, and 0.021-inch-thick porcelain-enamel face sheet with high-gloss finish. Note special music staff graphics required in some locations, reference drawings.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Basis of Design: Claridge, Product: Series 3 fixed marker boards. Reference drawings for specific sizes for this project. Note some custom sizes may occur.
      1) Center teaching wall markerboard shall have low gloss non-glare surface finish. Provide tack/cork strip continuous at top of markerboard.
   b. AARCO Products, Inc.; equivalent to above
   c. ADP Lemco, Inc. ; equivalent to above
   d. Ghent Manufacturing, Inc. ; equivalent to above
   e. Marsh Industries, Inc.; Visual Products Group. ; equivalent to above
   f. Platinum Visual Systems; ABC School Equipment, Inc; equivalent to above
   g. PolyVision Corporation; a Steelcase company. ; equivalent to above
   h. Tri-Best Visual Display Products; equivalent to above
2. Manufacturer's Standard Core: Minimum 1/4 inch thick, with manufacturer's standard moisture-barrier backing.
3. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.
4. Screen printed Music Staff Lines: Not Used.
5. Coordination with storage casework located behind sliding marker boards and support systems for visual display boards. Reference drawings for additional details.

2.3 MARKERBOARD ACCESSORIES

A. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- thick, extruded aluminum; standard size and shape.
   1. Factory-Applied Trim: Manufacturer's standard.

B. Chalktray: Manufacturer's standard, continuous.
   1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.

C. Map Rail: Provide the following accessories:
   1. Display Rail: Continuous and integral with map rail; fabricated from cork approximately 1 to 2 inches wide.
   2. End Stops: Located at each end of map rail.
   3. Map Hooks: Two map hooks for every 48 inches of map rail or fraction thereof.
   4. Flag Holder: One for each room. For all spaces with white boards, provide flag holder. Rooms included, but not limited to (gym, cafeteria, classrooms, offices, meeting rooms). Locate and note proposed flag holder locations on shop drawing submittal for Architect and Owner review prior to installation.

2.4 FABRICATION

A. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.

B. Visual Display Boards: Factory assembled visual display boards unless otherwise indicated.
   1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display boards at manufacturer's factory before shipment.

C. Factory-Assembled Visual Display Units: Coordinate factory-assembled units with trim and accessories indicated. Join parts with a neat, precision fit.

1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect, as indicated on approved Shop Drawings.
2. Provide manufacturer's standard vertical-joint H-trim system between abutting sections of markerboards.
3. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.

D. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to a neat, hairline closure.
1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Protect mechanical 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.

2.6 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
B. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
B. Examine walls and partitions for proper preparation and backing for visual display surfaces.
C. Examine walls & partitions for suitable framing depth where sliding visual display units will be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.
B. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.
C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display surfaces and wall surfaces.
1. Prime wall surfaces indicated to receive direct-applied, visual display tack wall panels and as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
2. Prepare surfaces to receive visual display wall coverings and test for moisture according to requirements specified in Division 09 Section "Wall Coverings."
3. Prepare substrates indicated to receive visual display wall covering as required by manufacturer's written instructions to achieve a smooth, dry, clean, structurally sound surface that is uniform in color.
a. Moisture Content: Maximum of 4 percent when tested with an electronic moisture meter.
b. Metals: If not factory primed, clean and apply metal as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.

c. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
d. Painted Surfaces: Treat areas susceptible to pigment bleeding.

D. Prepare recesses for sliding visual display units as required by type and size of unit.

3.3 INSTALLATION, GENERAL

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
1. Mounting Height 36 inches above finished floor to top of chalktray.

3.4 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY BOARDS AND ASSEMBLIES

A. Visual Display Boards: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches o.c. Secure both top and bottom of boards to walls.
1. Field-Applied Aluminum Trim: Attach trim over edges of visual display boards and conceal grounds and clips. Attach trim to boards with fasteners at not more than 24 inches o.c.
a. Attach chalktrays to boards with fasteners at not more than 12 inches o.c.

3.5 CLEANING AND PROTECTION

A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.
B. Touch up factory-applied finishes to restore damaged or soiled areas.
C. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 10 11 16

SECTION 10 11 23 – TACKBOARDS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes
   1. Tackable unframed wall panels, vinyl faced to match 09 72 00 color selection.
   2. Tackboards framed - vinyl wrapped to match 09 72 00 color selection.
   3. Coordinate installation and layout of tackable wall panels with adjacent wall mounted equipment.
   4. Coordination with storage casework located behind sliding boards and support systems for visual display boards. Reference drawings for additional details.

B. Related Sections include the following:
   1. Division 06 Section "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.
   2. Division 06 Section "Finish Carpentry" for interior carpentry exposed to view that is not specified in this Section.
   3. Division 06 Section "Interior Architectural Woodwork" for casework integration.
   4. Division 10 Section “Visual Display Surfaces” for sliding marker and tackboard applications.
   5. Division 22 Section “Plumbing” for rough-in and coordination of sinks, service fixtures and fittings, supply and waste lines, connections and vents incorporated into casework.
   6. Division 23 Section “HVAC” for coordination of ductwork and vents incorporated into casework.
   7. Division 26 Section “Electrical” for rough-in and coordination of electrical, phone, data outlets, J-boxes, conduit, fittings and cabinet lighting and controls incorporated into casework.

1.2 DEFINITIONS

A. Tackboard: Visual display surface that is factory fabricated into composite tackable panel form, either with or without a perimeter frame; includes tackboards.

1.3 REFERENCES

A. 2015 IBC /ASTM E 84 - Test Method for Surface-Burning Characteristics of Building Materials.
B. 2015 IBC - Test Method for Evaluating Room Fire Growth Contribution of Textile Wall Coverings.

1.4 SUBMITTALS

A. Submit product data and installation instructions under provisions of Division 1.
B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for visual display surfaces.
C. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.
   1. Show locations of panel joints.
   2. Show locations of special-purpose graphics for visual display surfaces.
   3. Include sections of typical trim members.
D. Product Schedule: For visual display surfaces. Use same designations indicated on Drawings.
E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.
F. Operation and Maintenance Data: For visual display surfaces to include in maintenance manuals.
G. Warranties: Sample of special warranties.
H. WSSP Submittals:
   1. Not Used.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 450 or less.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install visual display surfaces until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Field Measurements: Verify actual dimensions of construction contiguous with visual display surfaces by field measurements before fabrication.
   1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate work with other finish trades.

B. Sequence installation after all other finish work is completed in each room to receive panels.

1.8 MAINTENANCE

A. Provide 4 additional panels (of each size used on project) as extra stock, properly wrapped and identified.

B. Provide 25 linear feet of each color of fabric and vinyl used. Roll, wrap and identify. Scrap pieces are not acceptable.

PART 2 – PRODUCTS

2.1 MANUFACTURES

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
   1. Basis-of-Design Product: The design for each tile type is based on the product named in the finish schedule. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified

2.2 UNFRAMED TACKABLE WALL PANEL

A. Lamvin (800) 446-6329 Product: Soft-Tone Tackable Panels
B. Platinum Visual System (800) 498-2990 Product: Vinyl Wrapped Tackboard
C. Inwest Manufacturing (801) 514-5416 Product: TWS-WRP System
D. Jasco
E. Substitutions under provisions of Division 1.
F. Unframed Tackable Wall Panel Assembly
   1. Core: ½" Micore fiberboard as manufactured by USG.
   2. Surface: Vinyl Fabric covering with all edges wrapped (metal edges acceptable but not required).
      a. Flame Spread – Class A
      b. 100% polyester Type II Vinyls equal to:
         1. Koroseal Wall Covering: as specified in 09 72 00 – patterns varies
         2. Finish material on wrapped boards shall match VWC type as shown on 09 Finish Schedule. Vinyl wall finish in each room shall match both wall and tack board location utilizing the same pattern, color and style.
   3. Color: To match 09 72 00 as selected by Architect.
   4. Adhesive: Type recommended by panel manufacturer for application.

2.3 FRAMED TACKBOARD ASSEMBLIES

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

1. Basis of Design: Claridge Fabricork
   Reference drawings for specific sizes for this project. Note some custom sizes may occur.
2. Approved Manufacturers with equivalent products:
   a. A-1 Visual Systems.
   b. AARCO Products, Inc.
   c. ADP Lemco, Inc.
   d. Aywon.
   e. Bangor Cork Company, Inc.
   f. Best-Rite Manufacturing.
   g. Egan Visual Inc.
   h. Ghent Manufacturing, Inc.
   i. Marsh Industries, Inc.; Visual Products Group.
   j. Platinum Visual Systems; a division of ABC School Equipment, Inc.
   k. PolyVision Corporation; a Steelcase company.
   l. Tri-Best Visual Display Products.
3. Vinyl-Fabric-Faced Tackboard: 1/4-inch- thick, vinyl-fabric-faced cork sheet factory laminated to 1/4-inch- thick particleboard backing. Custom vinyl fabric required to match color and pattern selection listed on specification 09 72 00.
4. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- thick, extruded aluminum; standard size and shape.
5. Factory-Applied Trim: Manufacturer's standard.
6. Coordinate storage access at casework located behind sliding tackboards and support systems for visual display boards. Reference drawings for additional details.

2.4 FABRICATION

B. Visual Display Boards: Factory assembled visual display boards unless otherwise indicated.

C. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display boards at manufacturer's factory before shipment.

D. Factory-Assembled Visual Display Units: Coordinate factory-assembled units with trim and accessories indicated. Join parts with a neat, precision fit.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical 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.

2.6 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that substrate, adjacent materials and panels are dry and ready for installation.

3.2 EXECUTION

A. Adhere panels to walls in a true and level manner. Place panels in a method to maximize contact bedding. Butt ends tight to adjacent panels.

B. Joints for all materials shall not exceed 1/16” space, including all miter joints or the material shall be replaced.

C. Install tackboards level, plumb, true, and straight.

3.3 CLEANING

A. Clean in accordance with manufacturer's instructions.

3.4 PROTECTION OF FINISHED WORK

A. Protect work under provisions of Division 1.

END OF SECTION 10 11 23

SECTION 10 14 00 – SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Building Dedication Plaque
   2. Panel signs and sign assemblies
      a. Room identification signs
      b. Code required signage
      c. Directional signs
   3. Metal Letters, Exterior and Interior
   4. Metal Character
   5. Back Lit LED Channel Letters

B. Related Sections include the following:
   1. Division 01 Section "Temporary Facilities and Controls" for temporary Project identification signs and for temporary information and directional signs.
   2. Division 22 Section "Identification for Plumbing Piping and Equipment" for labels, tags, and nameplates for plumbing systems and equipment.
   3. Division 23 Section "Identification for HVAC Piping and Equipment" for labels, tags, and nameplates for HVAC systems and equipment.
   4. Division 26 Sections for electrical service and connections for illuminated signs.
   5. Division 26 Section "Identification for Electrical Systems" for labels, tags, and nameplates for electrical equipment.

1.2 DEFINITIONS

A. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: Show fabrication and installation details for signs.
   1. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
   2. Provide message list, typestyles, graphic elements including tactile characters and Braille, and layout for each sign.
C. Samples: For each of the following products and for the full range of color, texture, and sign material indicated, of sizes indicated:
   1. Aluminum: For each form, finish, and color, on 6-inch- long sections of extrusions and squares of sheet at least 4 by 4 inches.
   2. Acrylic Sheet: 8 by 10 inches for each color required.
   3. Polycarbonate Sheet: 8 by 10 inches for each color required.
   4. Panel Signs: Not less than 12 inches square including border.
   5. Accessories: Manufacturer's full-size unit.
D. Sign Schedule: Use same designations indicated on Drawings.
E. Qualification Data: For fabricator.
F. Maintenance Data: For signs to include in maintenance manuals.
G. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer>.

B. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
C. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.
D. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
E. Mock-up
1. Submit one (1) sample of each Sign Types and one (1) of all mounting systems to be used. The Owner reserves the right to disassemble any item and to subject items to any test necessary to determine its strength or character without being responsible for any damage to the item caused thereby. Samples will not be returned
2. Provide full scale mock-up of each sign type, including all anchorage and fastening methods for review and approval of the Architect. Coordinate full installation to include lighting, and related trades. When accepted the mock-up may remain in place, and will serve as the standard of acceptable quality for all other installations

1.5 PROJECT CONDITIONS
A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit installation of signs in exterior locations to be performed according to manufacturers' written instructions and warranty requirements.
B. Field Measurements: Verify recess openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.6 COORDINATION
A. Coordinate placement of anchorage devices with templates for installing signs.

1.7 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
a. Deterioration of metal and polymer finishes beyond normal weathering.
b. Deterioration of embedded graphic image colors and sign lamination.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).
B. Polycarbonate Sheet: Of thickness indicated, manufactured by extrusion process, coated on both surfaces with abrasion-resistant coating:
1. Impact Resistance: 16 ft-lbf/in. per ASTM D 256, Method A.
2. Tensile Strength: 9000 lbf/sq. in. per ASTM D 638.
3. Flexural Modulus of Elasticity: 340,000 lbf/sq. in. per ASTM D 790.
4. Heat Deflection: 265 deg F at 264 lbf/sq. in. per ASTM D 648.
5. Abrasion Resistance: 1.5 percent maximum haze increase for 100 revolutions of a Taber abraser with a load of 500 g per ASTM D 1044.
C. Applied Vinyl: Die-cut characters from vinyl film of nominal thickness of 3 mils with pressure-sensitive adhesive backing, suitable for exterior applications.

2.2 BUILDING DEDICATION PLAQUE
A. Basis-of-Design Product: Subject to compliance with requirements, provide signage system to match existing interior signs as manufactured by:

1. Plaque: Best Sign Systems - Similar to #228577. Signage script and dimensions as shown on drawings. Satin brass finish, engraved lettering filled in black. Lettering style: as indicated in drawing.
2. Substitutions under provisions of Division 01.

2.3 PANEL SIGNS

A. Basis-of-Design Product: Subject to compliance with requirements, provide signage system as manufactured by:
   1. Standard Room Identification Signs: Best; sign type as defined in sub-section “B” below:
   2. Subject to substitution request as provided in Division 01, alternate suppliers for these sign types are:
      a. Advance Corporation; Braille-Tac Division.
      b. Allen Industries Architectural Signage
      c. APCO Graphics, Inc.
      d. ASI-Modulex, Inc.
      e. Best Sign Systems Inc.
      f. Fossil Industries, Inc.
      g. Gemini Incorporated.
      h. Grimco, Inc.
      i. InPro Corporation
      j. Mohawk Sign Systems.
      k. Nelson-Harkins Industries.
      l. Seton Identification Products.
      m. Signature Signs, Incorporated.

B. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner, complying with the following requirements:
   1. Acrylic Sheet: 1/32 inch thick.
   2. Laminated Sheet: 1/8 inch phenolic with contrasting color laminated to acrylic face as selected by Architect from manufacturer's full range.
   3. Provide complete with 1” tall by width of the sign clear “window” insert slot (where noted)
   4. Edge Condition: Square cut.
   5. Corner Condition: Rounded to radius indicated.
   6. Mounting: Unframed.
      a. Wall mounted with exposed stainless steel anchors
      b. Manufacturer's standard anchors for substrates encountered.
      c. Reference interior detail sheets for additional mounting requirements.
   7. Tactile Characters: Characters and Grade 2 Braille raised 1/32 inch (0.8 mm) above surface with contrasting colors.

C. Brackets: Fabricate brackets and fittings for bracket-mounted flag signs from extruded aluminum to suit panel sign construction and mounting conditions indicated. Factory paint brackets in color matching background color of panel sign.

D. Tactile and Braille Sign: Manufacturer's standard process for producing text and symbols complying with ADA-ABA Accessibility Guidelines and with ICC/ANSI A117.1. Text shall be accompanied by Grade 2 Braille. Produce precisely formed characters with square-cut edges free from burrs and cut marks; Braille dots with domed or rounded shape.
   1. Panel Material: Opaque acrylic sheet.
   2. Raised-Copy Thickness: Not less than 1/32 inch.

E. Engraved Copy: Machine engrave letters, numbers, symbols, and other graphic devices into panel sign on face indicated to produce precisely formed copy.

F. Glass Mount Backers: Provide self-adhering vinyl backers at locations where panel signs are applied to glass. Size and shape shall match panel signage.
   1. Color: As selected by architect from manufacturer’s full range.

2.4 DIMENSIONAL CHARACTERS

A. Produce characters with smooth flat faces, sharp corners, and precisely formed lines and profiles, free of pits, scale, sand holes, and other defects. Cast lugs into back of characters and tap to receive threaded mounting studs. Alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Corporation; Braille-Tac Division.
2. A. R. K. Ramos.
3. ASI-Modulex, Inc.
4. Bunting Graphics, Inc.
5. Gemini Incorporated.
6. Grimco, Inc.
7. Metal Arts; Div. of L&H Mfg. Co.
8. Mills Manufacturing Company.
9. Mohawk Sign Systems.
10. Nelson-Harkins Industries.
11. Signature Signs, Incorporated.
12. Southwell Company (The).

C. METAL LETTERS
1. Wall mounted custom metal letters, interior and exterior applications, comply with the following requirements:
a. Character Material: Aluminum
b. Letter Thickness: 3/8” thick plate
c. Height, Typestyle, Color, Finish: Reference Drawings
d. Mounting: Conceal mounting stud cast in rear of letter
e. Provide spacers and shims for separation to prevent galvanic action between metals.
2. Provide full scale mounting template for Owner review, prior to installation of letters.

D. METAL CHARACTER
1. Wall mounted custom entry graphic, comply with the following requirements.
a. Character Material: Aluminum, Wall Sign
b. Character Thickness: 3/8” Thick Plate, radius all curves 1/4 inch minimum.
c. Height: Varies, Reference Drawings.
d. Typestyle: Varies, Reference Drawings.
e. Graphics: Electronic CAD files will be provided to the supplier in order to obtain graphic and actual size and the radius edge for specific patterns. Reference drawings for patterns and colors. Colors to be selected from full standard color range.
f. Mounting: Concealed metal fastener anchored to wall framing.
1) Minimum of (12) fasteners per panel section with two inch panel margin at perimeter, tack weld to rear of sign. Size anchor/weld relative to sign section for adequate support.
2) Coordinate standoff spacer at each fastener, holding sign off wall uniformly, minimum 1 inch.
3) Smooth exposed welds or fastener head at front side of sign for continuous and unblemished surface.
g. Powder Coat: provide powder coat finish as noted in drawings.
1) High Performance Organic FEVE Fluouropolmer Finish
2) Single-coat fluoropolmer finish complying with AAMA 2605 containing 100 percent Fluoro Ethylene Vinyl Ether
a) Clean and prepare metal to accept coating
b) Protect areas of sign not receiving coating finish, see drawings.
3) Prepare, pretreat and apply coating to exposed metal surfaces to comply with coating manufacturer recommendations
4) Colors: Solid color to be selected from manufacturer full standard color range, matte finish (10 gloss).

5) Basis of Design: IFS Coating, 300SP

2.5 VINYL LETTERS AND SIGNS

A. Custom Printed Wall Letters, 3M print cut vinyl with adhesive for vertical application.
   1. Finish: Matte vinyl
      a. White in color for way finding signage
      b. Multi-color for graphic wall signs
   2. Adhesive:
      a. Permanent self-adhesive for exterior application
      b. Permanent self-adhesive for indoor use – for painted gypsum board wall finish (level 5 smooth wall).
   3. Tape: Medium tack tape. Tape shall not remove graphic from surface when removed.

B. Size: Varies – reference drawings.

C. Colors and Patterns:
   1. Color, Pattern, Layout, Font: Reference drawings.
   2. Final letter layout, location, and design to be approved/review during shop drawing submittal by Owner and Architect prior to installation of any letters or signs.

D. Clean and dry surface prior to installing vinyl wall letters. Prepare surface finish per manufacturer's recommendation to accept vinyl wall letters.

E. Press/Squeegee image to be flat on wall free from raised seams and air bubbles.

F. At FDC, label with building address numbers. Coordinate exact requirements with local AHJ.

2.6 BACK LIT LED CHANNEL LETTERS

A. Exterior reverse metal channel fabricated letters.
   1. Size, Style, Quantity, Location: Reference drawings
   2. Material: Aluminum, 18 gauge
   3. Finish: Polish Aluminum, Reference drawings for color.
   4. Spacing: Evenly. Reference drawings.
   5. Light: Concealed LED illumination, UL approved, minimum 20 LED units evenly distributed around each letter profile. Provide voltage converter compatible with 277V branch lighting circuits.
   6. Back: Lexan rear letter cover, same shape as letter profile, to provide even light dispersal.
   7. Mount: Treaded rod and nut assembly. Hold letter one inch away from building substrate for back-lit light to glow behind each individual letter.

B. Fully conceal LED connector, wiring and back-boxes behind each letter. Coordinate letter locations with adjacent wall/building material and all construction trades. Space letters evenly. Reference drawings.

C. Power Supply: Provide one remote driver per every 10 sign letters, sized for LED lighting load. Coordinate location of interior driver with Owner prior to installing. Daisy-chain together each letter of each word for uniform operation.

D. Mock-Up: Provide single letter mock-up for review and approval, prior to ordering and installing remaining letters.

E. Product Information:
   1. Basis of Design: Mustang Sign, HALO Lit Channel Letter (Kennewick, WA)
      a. Gemini, HALO Lit Fabricated Aluminum Letter
      b. Electricore Signs, equivalent to product above.
      c. Substitution requests for approved equal per Division 01.

2.7 ACCESSORIES

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

2.8 WALL MURAL

A. Not Used.

2.9 FABRICATION

A. General: Provide manufacturer's standard signs of configurations indicated.
   1. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.
   2. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.
   3. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
   4. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

2.10 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

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

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

2.11 ACRYLIC SHEET FINISHES

A. Colored Coatings for Acrylic Sheet: For copy and background and frame colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for five years for application intended.

2.12 ALUMINUM FINISHES

A. Clear Anodic Finish: Manufacturer's standard Class 1 clear anodic coating, 0.018 mm or thicker, over a satin (directionally textured) mechanical finish, complying with AAMA 611.

2.13 STAINLESS-STEEL FINISHES

A. Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

B. Directional Satin Finish: No. 4 finish.

C. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.14 STEEL FINISHES

A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

B. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Verify that items, including anchor inserts are sized and located to accommodate signs.

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

3.2 INSTALLATION

A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.

1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches of sign without encountering protruding objects or standing within swing of door.

B. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.

1. Two-Face Tape: Mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
2. Magnetic Tape: Mount signs to smooth, nonporous surfaces.
3. Silicone-Adhesive Mounting: Attach signs to irregular, porous, or vinyl-covered surfaces.
4. Shim Plate Mounting: Provide 1/8-inch- thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other mounting methods are not practicable. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach panel signs to plate using method specified above.
5. Mechanical Fasteners: Use nonremovable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.

C. Dimensional Characters: Mount characters using standard fastening methods to comply with manufacturer's written instructions for character form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish character spacing and to locate holes for fasteners.

1. Projected Mounting: Mount characters at projection distance from wall surface 1/2 inch unless noted otherwise.

3.3 CLEANING AND PROTECTION

A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

END OF SECTION 10 14 00

SECTION 10 14 63 – ELECTRONIC READERBOARD

PART 1 GENERAL

1.1 SUMMARY

A. (Two) Single-Sided Electronic Exterior Readerboards
B. Electronic Readerboard Control Software.
C. Sign base construction and related connection of power and data for a fully functioning sign system.
D. All sign permit application, coordination, and payment of fees to Authorities having Jurisdiction. Provide shop drawings to AHJ as required for city signage permit. Verify existing easements, right-of-way requirements and property lines prior to starting construction of sign base.

1.2 REFERENCES

A. Standard for Electric Signs, UL-48, 13th Edition
B. Standard for Control Centers for Changing Message Type Signs, UL-1433, 1st Edition
C. Federal Communications Commission Regulation Part 15
D. National Electric Code

1.3 SUBMITTALS

A. Delegated Design: Design exterior sign systems to have performance requirements and design criteria indicated.
   1. Wind Loads: 90 mph, exposure B
   2. Seismic Loads: As indicated in the Structural Drawings
   3. Mounting requirements for sign installation and maintenance as indicated on Architectural Drawings.
B. Product data: Submit manufacturer's product illustrations, data and literature that fully describe the readerboards and accessories proposed for installation.
C. Shop drawings: Submit mechanical and electrical drawings.
D. Maintenance data: Submit manufacturer's installation, operation, and maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Product delivered to jobsite.
B. Readerboard and accessories to be housed in a dry, clean environment until the time of installation.

1.5 PROJECT CONDITIONS

A. Environmental limitations: Do not install scoreboard equipment until mounting structure is secure and concrete has ample time to cure.
B. Field measurements: Verify position and elevation of structure and its layout for readerboard equipment. Verify dimensions by field measurements.
C. Verify mounting structure is capable of supporting the scoreboard's weight and windload in addition to the auxiliary equipment.
D. Installation may proceed in acceptable weather conditions.

1.6 QUALITY ASSURANCE

A. For indoor and outdoor use.
B. Source limitations: Obtain all readerboard and related equipment through one source from a single manufacturer.
C. UL Listed
D. NEC and FCC Compliant

1.7 WARRANTY / SERVICE PLAN

A. There shall be a one-year coverage of electronic parts with four additional years of extended service coverage.

B. There shall be an exchange program that provides replacement parts for components that fail during the one-year coverage. To minimize downtime, the exchange parts shall be shipped on the same day that the order is received or on the following day. The manufacturer shall also enclose an air bill for return of the defective components.

C. There shall be a local Authorized Service Company.

D. A help desk staffed by experienced technicians and coordinators thoroughly familiar with the readerboard and software shall be available for technical support. This staff is available at no cost to the customer and is on call during weekends.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Basis of Design: WatchFire Time O-Matic

B. Other acceptable manufacturer:

1. WatchFire Daktronics
2. Trans-Lux

C. Substitutions: See Division 01 – Product Requirements

2.2 PRODUCT

A. Exterior Reader Boards (two total)

1. WatchFire Outdoor Full Color– 10 mm LED Display, provide electric power, 120 VAC, single phase electronic readerboard capable of displaying text, graphics, & animations.
2. Reader board sign case (full width) with internally illuminated permanent single-sided sign face.
3. Quantity: Two Displays (Back to Back)
4. Integrate LED displays into reader board assembly as shown in drawing. Coordinate and conceal rear steel clip mounting angles within display assembly.
5. Ignite Grapghics software for Windows based PC.

2.3 SIGN FACE & READERBOARD

A. Sign Face/Case

1. Dimensions: 11’ high, 5’ wide, 8” deep (vertical orientation)
2. Cabinet Color: Black
3. Feature: Internally illuminated sign face with permanent graphics.
4. Approximate Weight: 520 lbs
5. Metal Trim: Full sheet metal trim enclosure on all sides of the display face(s) to match color of sign assembly.

B. Features

1. Color: LED RGB
2. Color Capability: 1.15 Quintllion
3. Viewing Angle: 140-degree horizontal, 70-degree vertical.
4. Video: AVI, Animated Text, Graphics
5. Brightness: Daytime 9,000 NITs Maximum
6. Brightness: Nighttime 750 NITs Maximum
7. Matrix Size: 32 x 80
8. UL listed.

C. Communication Method

1. Fiber based TCP/IP Over Ethernet Communication System
2. Media converter (Media converter requires connection to a 120 vac power outlet.)
3. Provide Ethernet media converter to interface the signal with the owner’s

network. Owner to provide network configuration settings (IP address, Gateway address, and subnet mask.)

4. Provide multimode fiber for connection to communication box with integrated media converter by the manufacturer. Communications box from manufacture comes with a 30'-0" whip to connect to readerboard display. Multimode fiber to originate in main telecommunications room (TR-MC).

2.4 SOFTWARE

A. Features

1. Spell check for content creation.
2. Text filter to prevent the use of select words during message creations.
3. Import a single or series of images and graphics from a variety of formats.
4. Frame-by-frame user electable presentation effects for entry, hold, and exit transitions.
5. Creation of custom animation through in-program editing tools.
6. Message scheduling to allow pre-programmed start and stop times of messages more than one-year in advance.
7. Multiple messages can run on the display simultaneously, alternating between one and the next.
8. Addition of temperature, date, and time to any message in a variety of formats.
9. Built-in test sequence for display troubleshooting.
10. Automatic adjustment for daylight savings time.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that mounting structure is ready to receive readerboard faces. Verify that placement of conduit and junction boxes are as specified in plans and shop drawings. Verify that all concrete has cured adequately according to specifications.

3.2 INSTALLATION

A. All power and control cable to readerboard are to be routed in conduit. Conceal power and control wiring to the displays, as well as raceways shown on electrical plans, by the Electrical contractor. Verify all exposed conduit locations with Architect prior to installation.
B. Install full coverage sheet metal trim at all edges of the reader board assembly for full enclosure of rear, sides, top and bottom of display signs. Color shall match sign assembly.
C. Install readerboard faces to beams / structure in location detailed and in accordance with manufacturer's instructions. Verify unit is plumb and level.
D. Verify Earth Ground does not exceed 10 ohms.
E. Install reader board per drawings. Verify final sign height with Owner.
F. Verify exact sign location and orientation with Owner prior to installation.

3.3 INSTALLATION – CONTROL LOCATION

A. Provide boxes, cover plates and jacks in locations as required to conceal all wiring.

3.4 TRAINING

A. Perform one operator training session with end-user identified operators.
B. Training session to occur on-site.

END OF SECTION 10 14 63

SECTION 10 21 13 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY
- A. Section Includes:
  1. Solid-polymer toilet compartments configured as toilet enclosures and urinal screens.
- B. Related Sections:
  1. Division 06 Section "Rough Carpentry" for blocking.
  2. Division 10 Section "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories.

1.2 SUBMITTALS
- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachments to other work.
  1. Show locations of cutouts for compartment-mounted toilet accessories.
  2. Show locations of reinforcements for compartment-mounted grab bars.
  3. Show locations of centerlines of toilet fixtures.
- C. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
  1. Each type of material, color, and finish required for units, prepared on 6-inch- square Samples of same thickness and material indicated for Work.
  2. Each type of hardware and accessory.
- D. Product Certificates: For each type of toilet compartment, from manufacturer.
- E. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.3 QUALITY ASSURANCE
- A. Comply with requirements in GSA's CID-A-A-60003, "Partitions, Toilets, Complete."
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or another standard acceptable to authorities having jurisdiction, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. Flame-Spread Index: 75 or less.
  2. Smoke-Developed Index: 450 or less.
- C. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1 for toilet compartments designated as accessible.

1.4 PROJECT CONDITIONS
- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

1.5 WARRANTY
- A. Warranty: Provide Two-Year Warranty.
  1. Warranty shall cover installation, operation, materials and labor.
  2. Warranty shall commence on date of substantial completion.

PART 2 - PRODUCTS

2.1 MATERIALS
- A. Aluminum Castings: ASTM B 26.
- B. Aluminum Extrusions: ASTM B 221.

C. Steel Sheet: Commercial steel sheet for exposed applications; mill phosphatized and selected for smoothness.
   1. Electrolytically Zinc Coated: ASTM A 879/A 879M, 01Z.
   2. Hot-Dip Galvanized: ASTM A 653/A 653M, either hot-dip galvanized or galvannealed.
D. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.
E. Stainless-Steel Castings: ASTM A 743/A 743M.
F. Zamac: ASTM B 86, commercial zinc-alloy die castings.
G. Plastic Laminate: NEMA LD 3, general-purpose HGS grade, 0.048-inch (1.2-mm) nominal thickness.

2.2 SOLID-POLYMER UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Basis of Design: Scranton Products, Inc.; Product: Hiny Hider Solid Plastic HDPE
   2. Bobrick SCRC series toilet partitions
   3. Accurate Partitions Corporation; equivalent to above
   4. Bradley Corporation; equivalent to above.
   5. General Partitions Mfg. Corp.; ; equivalent to above
   6. Global Steel Products Corp. ; equivalent to above
   7. Hadrian Manufacturing Inc. ; equivalent to above
   8. Knickerbocker Partition Corporation; equivalent to above
   9. Sanymetal; a Crane Plumbing company; equivalent to above
B. Toilet-Enclosure Style: Overhead braced, Floor anchored.
C. Urinal-Screen Style: Wall anchored and supported
D. Door, Panel, Screen, and Pilaster Construction: Solid-polymer panel material, not less than 1 inch thick, seamless, with eased edges and with homogenous color and pattern throughout thickness of material.
   1. Hinges: Configure doors and pilasters to receive Institutional Series 8” no-ferrous hinges, full length u-channel support brackets, nylon bearings; throw-bolt surface latch.
   2. Heat-Sink Strip: Manufacturer's standard continuous, stainless-steel strip fastened to exposed bottom edges of solid-polymer components to prevent burning.
   3. Color and Pattern: One color and pattern as selected by Architect from manufacturer's full range.
   4. Door Jambs: Provide sight limiting overlapping ship lap edge at partition door vertical edges.
E. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; stainless steel.
F. Urinal-Screen Post: Manufacturer's standard post design of material matching the thickness and construction of pilasters; with shoe and sleeve matching that on the pilaster.
G. Brackets (Fittings):
   1. Stirrup Type: Ear or U-brackets, stainless steel.
   2. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

2.3 ACCESSORIES

A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
   1. Material: Stainless steel.
   2. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
   3. Coat Hook: Reference and coordinate with 10 28 00 “Toilet, Bath and Laundry Accessories”
   4. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
   5. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

2.4 FABRICATION
A. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
B. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
C. Urinal-Screen Posts: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment at bottoms of posts. Provide shoes and sleeves at posts to conceal anchorage.
D. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide, in-swinging doors for standard toilet compartments and 36-inch- wide, out-swinging doors with a minimum 32-inch- wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 INSTALLATION
A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
1. Maximum Clearances:
a. Pilasters and Panels: 1/2 inch.
b. Panels and Walls: 1 inch.
2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than two brackets attached near top and bottom of panel.
a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
b. Align brackets at pilasters with brackets at walls.
B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
C. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.
D. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.2 ADJUSTING
A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 10 21 13

SECTION 10 26 13 – CORNER GUARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Corner Guard System.

B. Related Sections include the following:
   1. Division 06 Section “Interior Finish Carpentry” for wood chair rail.
   2. Division 08 Section "Door Hardware" for metal armor, kick, mop, and push plates.
   3. Division 09 Section “Plastic Paneling” for FRP coordination.
   4. Division 09 Section “Gypsum Board” for wall finishes.
   5. Division 11 Section “Food Service Equipment” for stainless steel corner guards included with the food service equipment package.

1.2 SUBMITTALS

A. Product Data: Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes for each impact-resistant wall-protection unit.

B. Detail drawings indicating mounting details with the appropriate fasteners for specific project substrates.

C. Samples for verification purposes of corner guard, 6" long, in full size profiles of each type and color indicated.

D. Cleaning and maintenance instructions for door and wall protection systems.

E. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain impact-resistant wall-protection units through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall-protection units and are based on the specific system indicated. Refer to Division 01 Section "Quality Requirements."
   1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in unopened factory packaging to the jobsite and store in original packaging in a climate controlled location away from direct sunlight.
   1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
   2. Keep plastic sheet material out of direct sunlight.
   3. Store plastic wall-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F
      a. Store corner-guard covers in a vertical position.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install impact-resistant wall-protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F for not less than 72 hours before beginning installation and for the remainder of the construction period.

B. Field Measurements: Verify actual locations of walls, columns, and other construction contiguous with impact-resistant wall-protection units by field measurements before fabrication and indicate measurements on Shop Drawings.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall-protection units that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures.
      b. Deterioration of plastic and other materials beyond normal use.
   2. Warranty Period: Five years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Corner-Guards: provide amount equal to 5 percent of each type, and size of units installed, but no fewer than **(four)** units—for each size installed.

B. Include mounting and accessory components. Replacement materials shall be from same production run as installed units.

PART 2 - PRODUCTS

2.1 CORNER GUARDS

A. Surface-Mounted, Resilient, Stainless Steel Corner Guards: Mechanically anchored formed stainless steel angle; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition.
   1. Available Manufacturers:
      a. Basis of Design: Construction Specialties, Inc.; **Model CO-8**
      b. The Corner Guard Store; equivalent to above
      c. Koffler Sales Company; equivalent to above
   2. Guard: Formed stainless steel angle, minimum 16 gauge wall thickness; as follows:
      a. Profile: Nominal (two) 2-inch-long legs and 1/4-inch corner radius.
      b. Height: 4’-0” in length at chair rail conditions (coordinate to terminate under wood chair rail)
      c. Height: 6’-0” in length all other locations (with no chair rail)
      d. Color and Texture: #4 Satin, mill/brush finish
      e. Alloy: #304
   3. Coordinate installation of corner guard with rubber base below and wood chair rail above.

2.2 FABRICATION

A. Fabricate impact-resistant wall-protection units to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.

B. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.

C. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
   1. Examine walls to which impact-resistant wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment.

2. For impact-resistant wall-protection units attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Complete finishing operations, including painting, before installing impact-resistant wall-protection system components.

B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

A. General: Install impact-resistant wall-protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
1. Install with bottom of assembly at top of resilient base trim, and coordinate with adjacent trim conditions at top of installation
2. Coordinate corner guard installation with underlying materials and substrates.
3. Install impact-resistant wall-protection units in locations and at mounting heights indicated on Drawings.
4. Provide splices, mounting hardware, anchors, and other accessories required for a complete installation.
a. Adjust top height as required to ensure tight seams, and tight butt joints to adjacent finishes and trim pieces.

3.4 CLEANING

A. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.

B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 10 26 13

SECTION 10 28 00 - TOILET, BATH AND HEALTH CARE ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Washroom accessories.
   2. Health Care Equipment, including but not limited to exam room privacy curtains.
   3. Changing Stations.
   4. Electric Hand Dryers

B. Owner-Furnished Material: Reference individual items below.

C. Related Sections include the following:
   1. Division 09 Section "Tiling" for ceramic toilet and bath accessories.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include the following:
   1. Construction details and dimensions.
   2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
   3. Material and finish descriptions.
   4. Features that will be included for Project.
   5. Manufacturer's warranty: Sample of special warranty.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
   1. Identify locations using room designations indicated on Drawings.
   2. Identify products using designations indicated on Drawings.

C. Manufacturer's Installation Instructions: Indicate special installation requirements.

D. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.3 QUALITY ASSURANCE

A. Source Limitations: For products listed together in the same articles in Part 2, provide products of same manufacturer unless otherwise approved by Architect.

B. Store and handle equipment in a manner to avoid significant or permanent damage to materials.
   1. Accept equipment on site. Inspect on arrival for damage
   2. Comply with manufacturer's written instructions for minimum and maximum temperature requirements for storage.

1.4 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

C. Furnish exact counts of Owner-Furnished, Contractor-Installed items 60 days in advance of when the materials is needed for the orderly execution of the work. Coordinate in advance with the owner to determine the necessary backing and blocking to allow installation of the specified accessories.

D. Field Measurements: Verify actual dimensions of construction contiguous with equipment, including dimensions and heights of installation area, by field measurements before fabrication.

1.5 WARRANTY

A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, 0.0312-inch minimum nominal thickness, unless otherwise indicated.

B. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.0359-inch minimum nominal thickness.

C. Galvanized Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.

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

E. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

F. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).

G. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

H. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.2 WASHROOM ACCESSORIES

A. Provide wash room accessories as specified below, and as shown on the drawings. Not all accessories are shown in the drawings, the work consists of the items and installations defined below. Verify final locations with Owner and Architect prior to installation.

B. Basis-of-Design: The design for accessories is based on products indicated. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
   1. Bobrick Washroom Equipment, Inc.
   2. Bradley Corporation.
   3. Or approved substitution in accordance with Division 01 requirements

C. Toilet Tissue (Roll) Dispenser: *Owner Furnished, Contractor Installed*
   1. Mounting: Surface mounted, contractor shall coordinate and provide adequate wall backing for installation, install at each water closet location.

D. Paper Towel Dispenser: *Owner Furnished, Contractor Installed*
   1. Mounting: Surface mounted, contractor shall coordinate and provide adequate wall backing for installation, install at each lavatory location.

E. Soap Dispenser: *Owner Furnished, Contractor Installed*
   1. Mounting: Surface mounted, contractor shall coordinate and provide adequate wall backing for installation, install at each lavatory location

F. Seat Cover Dispenser: *Owner Furnished, Contractor Installed*
   1. Mounting: Surface mounted, contractor shall coordinate and provide adequate wall backing for installation, install above each unisex water closet location

G. Grab Bar:
   1. Basis-of-Design Product: Bobrick No. B-5806x36, 5806x42 and B-5806x18 at all disabled accessible water closet locations.
   2. Mounting: Surface mounted, contractor shall coordinate and provide adequate wall backing for installation.

H. Sanitary-Napkin Disposal Units: *Owner Furnished, Contractor Installed*
   1. Mounting: Surface mounted, contractor shall coordinate and provide adequate wall backing for installation, install at each water closet location in female and uni-sex staff restrooms.

I. Electric Hand Dryer Unit:
   1. Basis-of-Design Product: Excel XleratorEco XL-Greco – No Heat
      a. Graphite Zinc Die-Cast cover with auto sensor and noise reducing nozzle
      b. Power: 500 watts
      c. Size: 11” x 12” x 6”, roughly 16lbs
   2. Mounting: Surface mounted, contractor shall coordinate and provide adequate wall backing for installation
   3. Coordinate with Division 26 for electrical connections to hand dryer units
   4. Locate at all multi-stall restroom as indicated in the drawings

J. Mirror Unit:
1. Basis-of-Design Product: Bobrick B-290 with tempered glass, width indicated in drawings by 48” tall. Other sizes and locations as indicated.
2. Mounting: Surface mounted, contractor shall coordinate and provide adequate wall backing for installation
3. Locations as indicated in the drawings

K. Robe Hook:
1. Basis-of-Design Product: Bobrick B-672,
   a. Provide one on inside face of door at each uni-sex restroom.
   b. Provide one on inside face of door at each toilet compartment stall.
   c. Provide as noted in drawings.
2. Mounting: Surface mounted, contractor shall coordinate and provide adequate wall backing for installation. Mount at 54” above finish floor.

L. Mop Rack:
1. Basis-of-Design Product: Bobrick B-224, provide at every custodial (mop) fixture.
2. Mounting: Surface mounted, contractor shall coordinate and provide adequate wall backing for installation. Mount at height above finish floor as directed by Owner.

M. Shower curtain and rod
1. Not Used.

2.3 HEALTH CARE EQUIPMENT – EXAM ROOM CURTAINS

A. Exam Room Privacy Curtains
1. Manufacturer: Diamond Drapery Co. –
2. Curtain Track: Track System 5000 Series #5000-30 90 degree curve
   a. Ceiling mounted cordless aluminum track with matching splices; carriers with hooks; cordless hand traverse operations
   b. Track Material heavy duty extruded clear anodized aluminum cubicle track systems.
3. Curtain Material:
   a. Material: 100% polyester cubicle curtains. Fabric is to be opaque, washed, flame retardant and closely woven.
   b. Curtain top section: 20” height mesh at top of curtain panel, color “Snow”.
   c. Hems: top =1-1/2”, bottom and sides = 1”
   d. Grommets: 1/2 inch nickel plated metal grommets 6” on center – chrome finish
   e. Fabric: as selected from manufacturer’s full range of materials and colors.
   f. Fabrication: Height of curtains to be from 18 inches below ceiling mounted track to a distance of not more than 12 inches from the floor. Curtains to have 110 percent fullness, width to be determined by length of track to ensure proper enclosure.
   g. Apply stop or anchor curtain to wall at one end of the run.

B. Substitutions under provisions of Division 01 60 00.

2.4 CHILDCARE ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armedica
2. General Accessory Manufacturing Co. (GAMCO).
3. Koala Corporation.

B. Diaper-Changing Station:
1. Basis-of-Design Product: Koala Kare KB100-ST (Recess Mounted)
2. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap. Engineered to support a minimum of 250-lb static load when opened.
3. Mounting: Recess mounted within wall cavity with stainless steel flange. Unit shall not project more than 2 inches in closed position.
4. Operation: By pneumatic shock-absorbing mechanism.
5. Material and Finish: High-density polyethylene in manufacturer's standard color.
6. Location: Unisex Restroom 135 (one total unit).

C. Substitutions under provisions of Division 01 60 00.

2.5 UNDERLAVATORY GUARDS

A. Manufacturers: Subject to compliance with requirements, provide one of the following products:
   1. Plumberex Specialty Products, Inc.
   2. TCI Products.
   3. Truebro, Inc.

B. Underlavatory Guard:
   1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping, and allow service access without removing coverings.
   2. Material and Finish: Antimicrobial, molded-plastic, white.

2.6 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, 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.

C. Coordinate details with other work supporting, adjoining, or otherwise contacting items as required to ensure proper installation.

D. Verify that surfaces and above ceiling supports/backing are installed by the general contractor and are ready to receive work.

E. Verify exposed finishes have been applied, and setting conditions are dry, clean, and otherwise proper for installation

3.2 PREPARATION

A. Coordinate size and location of equipment indicated to be attached to or recessed into the building construction, and furnish anchoring devices with templates, diagrams, and instructions for their installation.

3.3 INSTALLATION

A. General: Install equipment, as required for a complete installation.

B. Follow all manufacturer’s recommendations and requirements for installation of the equipment.

C. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

D. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.

3.4 ADJUSTING AND CLEANING

A. Provide systems demonstration under provisions of Division 01. Demonstrate equipment operation.

B. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

C. Remove temporary labels and protective coatings.

D. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 10 28 00

SECTION 10 41 16 - EMERGENCY KEY CABINETS

PART 1 - GENERAL

1.1 SUMMARY
- A. Section Includes
  1. Lock Boxes.
  2. Provide two (2) at each building.

1.2 SUBMITTALS
- A. General: Under the provisions of Division 01, submit the following: Product data consisting of manufacturer's technical data and installation instructions.

1.3 QUALITY ASSURANCE
- A. Verify and comply with requirements of the Local Fire Marshall.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
- A. The Knox Company
  1. Product: Knox-Box 3200-R Recessed, with recessed mounting kit, dark bronze finish. Verify with City Fire Department for model number.

PART 3 - EXECUTION

3.1 PREPARATION
- A. Obtain purchase order application from the Local Fire Marshall.
- B. Purchase units.
- C. Coordinate location and installation with the Local Fire Marshall.
- D. Provide wiring for integration of tamper notification through building security system. Coordinate wiring requirements with electrician.

3.2 INSTALLATION
- A. Install units to comply with manufacturer's instructions.
- B. Connect tamper notification alarm to building security system.
- C. Final acceptance is contingent upon compliance with the Local Fire Marshal requirements. Coordinate exact location with Fire Marshal.
  1. The Fire Department requires Knox-box brand FDC caps and plugs. Remote FDC’s shall be painted red with an exterior paint.
  2. With vinyl lettering, label FDC with address of building. See specification 10 14 00.

END OF SECTION 10 41 16

SECTION 10 44 00 - FIRE EXTINGUISHERS & EMERGENCY CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire protection cabinets for the following:
   a. Portable fire extinguishers.
   b. AED cabinets
2. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.
3. Provide one new Type “K” fire extinguisher on wall mount bracket within 30’ of the cooking area of the food service kitchen. Coordinate exact location and mounting with Architect.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.

1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.

B. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

C. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Size: 6 by 6 inches square.

E. Product Schedule: For fire protection cabinets. Coordinate final fire protection cabinet schedule with fire extinguisher schedule to ensure proper fit and function. Use same designations indicated on Drawings.

F. Product Schedule: For fire extinguishers. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.

G. Maintenance Data: For fire protection cabinets to include in maintenance manuals.

H. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

I. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FMG.

1.4 COORDINATION

A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire protection cabinets with wall depths.

C. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of hydrostatic test according to NFPA 10.
      b. Faulty operation of valves or release levers.
   2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Basis of Design: J. L. Industries, Inc.; a division of Activar Construction Products Group – Cosmic 6E and Saturn 15 (type K extinguisher)
      b. Amerex Corporation, product equivalent to above
      c. Ansul Incorporated; Tyco International Ltd. , product equivalent to above
      d. Larsen's Manufacturing Company., product equivalent to above
      e. Moon-American. , product equivalent to above
      f. Pem All Fire Extinguisher Corp.; a division of PEM Systems, Inc. , product equivalent to above
      g. Potter Roemer LLC. , product equivalent to above
      h. Pyro-Chem; Tyco Safety Products. , product equivalent to above
   2. Valves: Manufacturer's standard
   3. Handles and Levers: Manufacturer's standard.
   4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
   5. Finish: Red Enamel

B. Multipurpose Dry-Chemical Type in Aluminum Container : UL-rated 3-A:40-B:C, 6-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-aluminum container.

2.2 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Basis of Design: J. L. Industries, Inc.; a division of Activar Construction Products Group.
      b. Amerex Corporation.
      c. Ansul Incorporated; Tyco International Ltd.
      d. Larsen's Manufacturing Company.
      e. Potter Roemer LLC.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
   1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
      a. Orientation: Vertical.

2.3 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

B. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
   1. Sheet: ASTM B 209.
   2. Extruded Shapes: ASTM B 221.
C. Stainless-Steel Sheet: ASTM A 666, Type 304.
D. Clear Acrylic View Window.

2.4 FIRE PROTECTION CABINET
A. Cabinet Type: Suitable for fire extinguisher.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Basis of Design: J. L. Industries, Inc., a division of Activar Construction Products Group; Panorama Recessed No. 1016Q43V.
      b. Larsen's Manufacturing Company; equivalent to above.
      c. Modern Metal Products, Division of Technico Inc.; equivalent to above.
      d. Moon-American; equivalent to above.
      e. Potter Roemer LLC; equivalent to above.
      f. Watrous Division, American Specialties, Inc.; equivalent to above.
B. Cabinet Construction: Nonrated.
C. Cabinet Material: Steel sheet.
   1. Shelf: Same metal and finish as cabinet.
D. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Provide where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semirecessed cabinet installation.
   1. Square-Edge Trim: 1-1/4- to 1-1/2-inch backbend depth.
E. Cabinet Trim Material: Steel sheet.
F. Door Material: Steel sheet.
G. Door Style: Fully glazed panel with frame.
H. Door Glazing: Clear Acrylic. Omit door glazing in all high activity areas (gymnasiums, multi-purpose rooms).
I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
   1. Provide recessed door pull and friction latch.
   2. Provide continuous hinge, of same material and finish as trim permitting door to open 180 degrees.
J. Accessories:
   1. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
      a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER."
         1) Location: Applied to cabinet door.
         2) Application Process: Silk-screened.
         3) Lettering Color: Red.
         4) Orientation: Vertical.
K. Finishes:
   1. Manufacturer's standard baked-enamel paint for the following:
      a. Exterior of cabinet door, and trim except for those surfaces indicated to receive another finish.
      b. Interior of cabinet and door.

2.5 AED DEVICE CABINET
A. Cabinet Type: Suitable for AED device.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Basis of Design: 1400 Lifestart Series AED Cabinet

B. Cabinet Construction: Nonrated.
C. Cabinet Material: Steel sheet with rolled edges.
D. Semi-Recessed Cabinet: Cabinet box semi-recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
E. Cabinet Trim Material: Steel sheet.
F. Door Material: Steel sheet.
G. Door Style: Fully glazed panel with frame.
H. Door Glazing: Clear Acrylic.
I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
J. Metal cabinet supplied complete with local alarm and highly visible strobe light that are triggered when the door is opened to make it widely-known that an emergency is in progress. Do not wire the alarm into a building's security system. Alarm shall be enabled or disabled with the key provided.
K. Cabinet Power: Energized for local alarm.
L. Finishes: Manufacturer's standard baked-enamel paint.
M. Quantity: (2) Locations. Reference drawings.
N. Keys: Provide (2) keys with each cabinet.

2.6 EVACUATION CHAIR AND CABINET

A. Not Used.

2.7 FABRICATION

A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
   1. Weld joints and grind smooth.
   2. Provide factory-drilled mounting holes.
   3. Prepare doors and frames to receive locks.
B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
   1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
   2. Fabricate door frames of one-piece construction with edges flanged.
   3. Miter and weld perimeter door frames.
C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.8 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
C. Finish fire protection cabinets after assembly.
D. 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.

2.9 STEEL FINISHES

A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
B. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for cabinets to verify actual locations of piping connections before cabinet installation.
B. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.
D. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for recessed and semirecessed fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights indicated below:
   1. Fire Protection Cabinets: 54 inches above finished floor to top of cabinet.
B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
   1. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semirecessed fire protection cabinets.
   2. Provide inside latch and lock for break-glass panels.
   3. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.
C. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
   1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.
D. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.
E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 00

SECTION 10 51 13 - METAL LOCKERS

PART 1 - GENERAL

1.1 SUMMARY
- A. Section Includes:
  1. New metal lockers, as indicated in the drawings.
  2. Locker Accessories, hardware, tops, metal base and filler panels

1.2 SUBMITTALS
- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker and bench.
- B. Shop Drawings: For metal lockers. Include plans, elevations, sections, details, and attachments to other work.
  1. Show locker trim and accessories.
  2. Include locker identification system and numbering sequence.
- C. Samples for Verification: For metal lockers and locker benches, in manufacturer's standard sizes.
- D. Qualification Data: For qualified Installer.
- E. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.
- F. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE
- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain metal lockers locker benches, and accessories from single source from single manufacturer.
- C. Regulatory Requirements: Where metal lockers and benches shall comply with accessibility requirements, comply with [the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1.

1.4 DELIVERY, STORAGE, AND HANDLING
- A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.
- B. Deliver master and control keys combination control charts to Owner by registered mail or overnight package service.

1.5 PROJECT CONDITIONS
- A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.
- B. Field Verify existing lockers to be relocated. Review configuration, mounting and attachment conditions.

1.6 COORDINATION
- A. Coordinate sizes and locations of concrete bases for metal lockers.
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.7 WARRANTY
- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures.
   b. Faulty operation of latches and other door hardware.
2. Damage from deliberate destruction and vandalism is excluded.
3. Warranty Period for All-Welded Metal Lockers: Lifetime from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Full-size units of the following metal locker hardware items equal to 10 percent of amount installed for each type and finish installed, but no fewer than three units:
      a. Locks.
      b. Identification plates.
      c. Hooks.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with A60 zinc-iron, alloy (galvannealed) coating designation.
C. Expanded Metal: ASTM F 1267, Type II (flattened), Class I, 3/4-inch steel mesh, with at least 70 percent open area.
D. Stainless-Steel Sheet: ASTM A 666, Type 304.
E. Extruded Aluminum: ASTM B 221, alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated.
F. Steel Tube: ASTM A 500, cold rolled.
G. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.
H. Anchors: Material, type, and size required for secure anchorage to each substrate.
   1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls for corrosion resistance.
   2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.2 METAL CORRIDOR LOCKERS

A. Products: Subject to compliance with requirements, provide one of the following:
   1. All-Welded, Metal Lockers:
      a. STAFF and KITCHEN LOCKERS
         1) Basis of Design: DeBourgh Mfg. Co.; **Corregidoor** Corridor Lockers. Multiple Tier, ADA compliant, see drawings for configuration and quantities:
            a) Provide clasp and latch for owner provided padlock.
            b) Staff Locker – Double Tier, 12” wide, 12” deep and 36” tall
      b. STUDENT LOCKERS
         1) Basis of Design: DeBourgh Mfg. Co.; **Apex Athlete** Lockers. Multiple Tier, ADA compliant, see drawings for configuration and quantities:
            a) Provide clasp and latch for owner provided padlock.
            b) Student Lockers - Triple Tier, 18” wide, 18” deep, and 18” tall
      c. Art Metal Products; product equivalent to above.
      d. List Industries Inc.; product equivalent to above.
      e. Lyon Workspace Products, LLC; product equivalent to above.
      f. Penco Products, Inc.; product equivalent to above.
      g. Republic Storage Systems Company; product equivalent to above .
B. Lockers to be welded unibody construction with exposed welds sanded smooth

C. Locker Arrangement: ADA Compliant, Single, Double and Triple tier.
D. Material: Cold-rolled steel sheet.
E. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:
    1. Exterior sides, Tops, Bottoms, Tier Dividers and Facia: Constructed of 16 gauge domestic cold rolled sheet steel for maximum durability.
    2. Backs: Solid sheet of 18 gauge cold rolled sheet steel welded to frames of sides and intermediate partitions.
    3. Shelves and Intermediate Partitions: Constructed of 18 gauge cold rolled sheet steel welded to sides and intermediate partition construction. Shelves provided in lockers 60 inches and taller, located to provide a minimum of 12 inches clearance.
F. Continuous Door Strike: Tier dividers, tops and bottoms constructed of 18 ga. to provide four-sided, continuous door strike for a secure, sanitary and intrusion-free locker while door is in closed position.
G. Doors:
    1. Doors are 16 gauge steel, formed outer panel with double bends on both sides and a single bend on top and bottom with 18 gauge steel formed stiffener panel.
    2. Door stiffener runs top to bottom on hinge side of door and is securely welded to outer door to form a reinforced channel for additional torque-free strength and sound reduction when closing door. (Inner panel not available on 9 inch wide or box lockers 12 inches high or less).
    3. Door Ventilation: Louvered doors with six louvers at the top and bottom of the formed door
    4. Latching
        a. Eleven gauge unbreakable stationary latch welded to the locker frame extending through no more than 1-1/4 inches into locker opening.
        b. Latch protrudes through flush-mounted, recessed stainless steel cup
        c. Capable of accepting padlock or built-in lock
H. Hinges:
    1. 16 gauge continuous piano hinge on the right side of the opening.
    2. Hinges welded to door and riveted to locker frame.
I. Base:
    1. 4 inch high, 14 Ga welded steel base enclosed on all four sides securely welded to locker bottom.
J. Reinforced bottom:
    1. 16 gauge spacer channel welded to loccer bottom front to back. Spacer channel to have full height 1/2”-inch ID tube welded over anchor holes to eliminate deflection.
K. Filler Panels: Manufacturer’s standard 18 gauge solid steel finished to match lockers.
L. Finish:
    1. Complete locker unit to be thoroughly cleaned, phosphatized and sealed
    2. Finish to be baked pure TGIC polyester powder coat with a minimum 2-3 mil thickness.
    3. Color of lockers shall be chosen from manufacturer’s full standard colors range.
M. Accessories:
    1. Continuous Sloping Tops: Fabricated from 0.048-inch nominal-thickness steel sheet, with a pitch of approximately 20 degrees.
        a. Closures: Hipped-end type.
    2. Recess Trim: Fabricated from 0.048-inch nominal-thickness steel sheet.
    3. Filler Panels: Fabricated from 0.048-inch nominal-thickness steel sheet.
    4. Boxed End Panels: Fabricated from 0.060-inch nominal-thickness steel sheet.
    5. Equip each metal locker with identification plate:
        a. Furnish each locker with polished aluminum number plate with etched black numbers.
        b. Locate number plate near center of each door.
        c. Owner to furnish numbering sequence.
    6. Single and Double-Tier Units: One double-prong ceiling hook and two single-prong wall hooks.
    7. Upper shelf: Fabricated from 0.048-inch nominal-thickness steel sheet.

2.3 FABRICATION

A. Fabricate metal lockers square, rigid, and without warp and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.
   1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
   2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.
B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments. Factory weld frame members of each metal locker together to form a rigid, one-piece assembly.
C. All-Welded Construction: Factory preassemble metal lockers by welding all joints, seams, and connections; with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds flush.
D. Accessible Lockers: Fabricate as follows:
   1. Locate bottom shelf no lower than 15 inches above the floor.
   2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.
E. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.
F. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch high.
G. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.
   1. Sloping-top corner fillers, mitered.
H. Recess Trim: Fabricated with minimum 2-1/2-inch face width and in lengths as long as practical; finished to match lockers.
I. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.
J. Boxed End Panels: Fabricated with 1-inch- wide edge dimension, and designed for concealing fasteners and holes at exposed ends of nonrecessed metal lockers; finished to match lockers.
   1. Provide one-piece panels for double-row (back-to-back) locker ends.
K. Finished End Panels: Designed for concealing unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.
   1. Provide one-piece panels for double-row (back-to-back) locker ends.
L. Center Dividers: Full-depth, vertical partitions between bottom and shelf; finished to match lockers.

2.4 STEEL SHEET FINISHES

A. Factory finish steel surfaces and accessories except stainless-steel and chrome-plated surfaces.
B. Powder Coat: TGIC polyester powder coat finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install level, plumb, and true; shim as required, using concealed shims.
   1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
   2. Anchor single rows of metal lockers to walls near top of lockers and to floor.
   3. Anchor back-to-back metal lockers to floor.

B. All-Welded Metal Lockers: Connect groups together with standard fasteners, with no exposed fasteners on face frames.

C. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
   1. Attach hooks with at least two fasteners.
   2. Attach door locks on doors using security-type fasteners.
   3. Identification Plates: Identify metal lockers with identification indicated on Drawings.
      a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
      b. Attach plates to upper shelf of each open-front metal locker, centered, with a least two aluminum rivets.
   4. Attach recess trim to recessed metal lockers with concealed clips.
   5. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
   6. Attach sloping-top units to metal lockers, with closures at exposed ends.
   7. Attach boxed end panels with concealed fasteners to conceal exposed ends of nonrecessed metal lockers.
   8. Attach finished end panels with fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.

3.3 ADJUSTING, CLEANING, AND PROTECTION

A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding. Verify that integral locking devices operate properly.

B. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.

C. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 10 51 13

SECTION 10 55 00 - POSTAL SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY
- A. Section Includes:
  1. Mailbox with hinged doors, pedestal mount.
- B. Related Sections:
  1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES
- A. American Architectural Manufacturers Association (AAMA) 611 - Voluntary Specification for Anodized Architectural Aluminum.
- B. ASTM International (ASTM):
  1. A591/A591M - Standard Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Weight (Mass) Applications.
  2. A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
  3. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
  4. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
  5. E527 - Practice for Numbering Metals and Alloys.
- C. United States Postal Service (USPS) Standard 4C - Standards Governing the Design of Wall-Mounted Centralized Mail Receptacles.

1.3 SUBMITTALS
- A. Submittals for Review:
  1. Shop Drawings: Include plan, elevations, dimensions, materials, finishes, hardware, accessories, and numbering system.
  2. Coordinate product information with city and local post office for compliance approval.

1.4 QUALITY ASSURANCE
- A. Regulatory Requirements: Conform to USPS 4C.
- B. Conform to ADA accessibility code for mailbox units.

PART 2 PRODUCTS

2.1 MANUFACTURERS
- A. Design Basis: Contract Documents are based on products by:
  1. Mailboxes.com: Salsbury 4200 Series, Pedestal Drop Box
     - a. Model Number: 4276 – Pedestal Drop Box – large; 23”w x 55.5”t x 19”d, Option A
     - b. Weight: 65 pounds
     - c. Color: Custom color to match building – coordinate with Owner.
     - d. Matching pedestal – model number 4280
     - e. Key keeper – recessed mount model number 1090 for U.S.P.S. access.
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS
- A. Aluminum:
  1. Extrusions: ASTM B221, 6063-T5 or T6 alloy and temper.
  2. Sheet: ASTM B209, alloy suitable for forming and finishing as specified.

2.3 FABRICATION

A. Pedestal Mailbox:
   1. Type: Pedestal mounted, front and rear loading. No slot.
   2. Enclosure:
      a. Aluminum construction with rain hood.
      b. Hinged rear cover for USPS access with 3-point latching system prepared for USPS lock.
   3. Doors:
      a. Aluminum extrusions, full rear and front, with piano hinges. No slot.
      b. Locks: Five pin spring bolt type cylinder locks; each lock keyed differently. Furnish two keys per lock.
   4. Pedestal: Formed steel sheet, minimum 14 gage, with top and base plates.

2.4 FINISHES
A. Aluminum: AAMA 611, Architectural Class I anodized to 0.0007 inch minimum thickness, custom color to be selected by Owner.

PART 3 EXECUTION

3.1 INSTALLATION
A. Install in accordance with manufacturer's instructions and approved Shop Drawings. Verify exact location of postal unit with Owner and local post office prior to installation.
B. Set plumb, level, and aligned.
C. Attach to supporting construction using anchor type best suited to substrate. Conceal fasteners. Anchor to concrete walk.
D. Fit trim with tight corners and intersections.

END OF SECTION 10 55 00

SECTION 10 75 16 - GROUND-SET FLAGPOLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes ground-set flagpoles made from aluminum.

B. Owner-Furnished Material: Flags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, operating characteristics, fittings, accessories, and finishes for flagpoles.

B. Shop Drawings: For flagpoles.

1. Include plans, elevations, and attachment details. Show general arrangement, jointing, fittings, accessories, grounding, anchoring, and support.
2. Include section, and details of foundation system.

C. Samples for Verification: For each type of exposed finish, in manufacturer's standard sizes.

D. Delegated-Design Submittal: For flagpoles.

1.4 CLOSEOUT SUBMITTALS

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Spiral wrap flagpoles with heavy paper and enclose in a hard fiber tube or other protective container.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain flagpoles as complete units, including fittings, accessories, bases, and anchorage devices, from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design flagpole assemblies.

B. Seismic Performance: Flagpole assemblies shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

C. Structural Performance: Flagpole assemblies, including anchorages and supports, shall withstand design loads indicated within limits and under conditions indicated.

1. Wind Loads: Determine according to NAAMM FP 1001. Basic wind speed for Project location in Pasco, WA wind speed 110 mph.
2. Base flagpole design on polyester, nylon or cotton flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.

2.3 ALUMINUM FLAGPOLES

A. Aluminum Flagpoles: Cone-tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B241/B241M, Alloy 6063, with a minimum wall thickness of 3/16 inch (4.8 mm).

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

a. American Flagpole

2. Brushed aluminum finish

B. Exposed Height: 25 feet (7.5 m).

C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:

1. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

D. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, 0.060-inch (1.52-mm) wall thickness with 3/16-inch (4.8-mm) steel bottom plate and support plate; 3/4-inch- (19-mm-) diameter, steel ground spike; and steel centering

wedges welded together. Galvanize foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.

1. Flashing Collar: Same material and finish as flagpole.

E. Sleeve for Aluminum Flagpole: Fiberglass or PVC pipe foundation sleeve, made to fit flagpole, for casting into concrete foundation.

1. Flashing Collar: Same material and finish as flagpole.

F. Cast-Metal Shoe Base: Made from aluminum with same finish and color as flagpoles for anchor-bolt mounting; furnish with anchor bolts.

1. Furnish ground spike.

G. Hinged Baseplate: Cast-metal tilting hinged base and anchor plate joined by permanently secured pivot rod. Furnish with stainless-steel screws for securing tilting base to anchor plate when not tilted; furnish with anchor bolts.

1. Finish: Same as flagpole.
2. Furnish aluminum base or aluminum flashing collar finished to match flagpole.
3. Furnish ground spike.

H. Pivoting Tilt Base: Steel baseplate with channel or rectangular tube uprights, pivot bolt, and locking device for tilting flagpole. Furnish tilting flagpole with steel counterweight box and weights, or furnish with internal counterweight. Furnish base with anchor bolts.

1. Finish: Same as flagpole.
2. Furnish ground spike.

2.4 FITTINGS

A. Finial Ball: Flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter.

1. 0.063-inch (1.6-mm) spun aluminum, finished to match flagpole.
2. 20-oz. (0.70-mm) copper with 23-karat, gold-leaf finish.
3. Spun stainless steel, finished to match flagpole.
4. Spun copper alloy, finished to match flagpole.

B. Internal Halyard, Winch System: Manually operated winch with control stop device and removable handle, stainless-steel cable halyard, and concealed revolving truck assembly with plastic-coated counterweight and sling. Furnish flush access door secured with cylinder lock. Finish truck assembly to match flagpole.

1. Halyard Flag Snaps: Stainless-steel swivel snap hooks with neoprene or vinyl covers. Furnish two per halyard.
2. Plastic Halyard Flag Clips: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Furnish two per halyard.

a. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:

1) Acme/Lingo Flagpoles, LLC.

2.5 MISCELLANEOUS MATERIALS

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

B. Drainage Material: Crushed stone, or crushed or uncrushed gravel; coarse aggregate.

C. Sand: ASTM C33/C33M, fine aggregate.

D. Elastomeric Joint Sealant: Single-component neutral-curing silicone joint sealant complying with requirements in Section 079200 "Joint Sealants."

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 ALUMINUM FINISHES

A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44.

1. Color: Black.
2. 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 PREPARATION

A. Prepare uncoated metal flagpoles that are set in foundation tubes by painting below-grade portions with a heavy coat of bituminous paint.

B. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Place and compact drainage material at excavation bottom.

C. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms to prevent displacement during concreting.

D. Foundation Tube: Place foundation tube, center, and brace to prevent displacement during concreting. Place concrete. Plumb and level foundation tube and allow concrete to cure.

E. Sleeves: Locate and secure sleeves in forms by bracing to reinforcement and forms.

F. Anchor Bolts: Locate and secure anchor bolts in forms with templates and by tying to reinforcement.

G. Place concrete, as specified in Section 033000 "Cast-in-Place Concrete." Compact concrete in place by using vibrators. Moist-cure exposed concrete for no fewer than seven days or use nonstaining curing compound.

H. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of concrete base.

3.2 FLAGPOLE INSTALLATION

A. General: Install flagpoles where indicated and according to Shop Drawings and manufacturer's written instructions.

B. Foundation Tube: Place flagpole in tube, seated on bottom plate between steel centering wedges, and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch (50-mm) layer of elastomeric joint sealant and cover with flashing collar.

C. Baseplate: Cast anchor bolts in concrete foundation. Install baseplate on washers placed over leveling nuts on anchor bolts and adjust until flagpole is plumb. After flagpole is plumb, tighten retaining nuts and fill space under baseplate solidly with nonshrink, nonmetallic grout. Finish exposed grout surfaces smooth and slope 45 degrees away from edges of baseplate.

END OF SECTION 107516

DIVISION 11 – EQUIPMENT

SECTION 11 13 00 - LOADING DOCK EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
- A. Section Includes:
  1. Dock bumpers.
- B. Related Sections:
  1. Division 03 Section "Cast-in-Place Concrete" for concrete work for recessed loading dock equipment.

1.2 SUBMITTALS
- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for loading dock equipment. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For loading dock equipment. Include plans, elevations, sections, details, and attachments to other work.
  1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Qualification Data: For qualified Installer.
- D. Operation and Maintenance Data: For loading dock equipment to include in operation and maintenance manuals.
- E. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE
- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain loading dock equipment from single source from single manufacturer.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
  1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.4 DELIVERY, STORAGE, AND HANDLING
- A. Store and handle dock bumpers in a manner to avoid significant or permanent damage to fabric or frame.
  1. Comply with manufacturer's written instructions for minimum and maximum temperature requirements for storage.

1.5 PROJECT CONDITIONS
- A. Field Measurements: Verify actual dimensions of construction contiguous with loading dock equipment, including recessed pit dimensions and heights of loading docks, by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS
- A. Steel Plates, Shapes, and Bars: ASTM 36/A 36M.
- B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from steel plate complying with ASTM A 572/A 572M, Grade 55 (380).
- C. Steel Tubing: ASTM A 500, cold formed.
- D. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- E. Wood: DOC PS 20 dimension lumber, select structural grade, kiln dried.

F. Pressure-Treated Wood: DOC PS 20 dimension lumber, select structural grade, kiln dried, and pressure treated with waterborne preservatives to comply with AWPA C2.

2.2 DOCK BUMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Floor Products Company, Inc.
   2. Beacon Industries, Inc.
   3. Chalfant Dock Equipment.
   4. Durable Corporation.
   5. Ellis Industries, Inc.
   6. Flexon, Inc.
   7. Hugger Dock Equipment Company; Division of Columbus Foam Products, Inc.
   8. Pawling Corporation; Architectural Products Division.
   9. Pentalift Equipment Corporation.
   10. Pioneer Loading Dock Equipment.
   11. Rite-Hite Corporation.
   12. Rol-Lift Corporation.
   13. SPX Dock Products - Kelley.
   14. SPX Dock Products - Serco.
   15. Super Seal Mfg. Ltd.
   16. Tennessee Mat Company, Inc.
   17. Vestil Manufacturing Company.

B. Laminated-Tread Dock Bumper: Fabricated from multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two 3/4-inch- diameter, steel supporting rods that are welded at one end to 1/4-inch- thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than 1 inch of tread plies extending beyond the face of closure angles.
   1. Thickness: 6 inches.
   2. Horizontal Style: 12 inches high by 24 inches.
   3. Quantity: 10 total (evenly spaced across width of loading dock)
   4. Color: Black

C. Anchorage Devices: Hot-dip galvanized-steel anchor bolts, nuts, washers, bolts, sleeves, cast-in-place plates, and other anchorage devices as required to fasten bumpers securely in place and to suit installation type indicated.

2.3 STEEL FINISHES

A. Galvanizing: Hot-dip galvanize components as indicated to comply with the following:
   1. ASTM A 123/A 123M for iron and steel loading dock equipment.
   2. ASTM A 153/A 153M or ASTM F 2329 for iron and steel hardware for loading dock equipment.

B. Galvanized-Steel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat in manufacturer's standard color.

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 loading dock equipment.

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

3.2 PREPARATION

A. Coordinate size and location of loading dock equipment indicated to be attached to or recessed into concrete or masonry, and furnish anchoring devices with templates, diagrams, and instructions for their installation.

B. Set curb angles in concrete edges of dock-leveler recessed pits with tops flush with loading platform. Fit exposed connections together to form hairline joints.

3.3 INSTALLATION

A. General: Install loading dock equipment, as required for a complete installation.

B. Dock Bumpers: Attach dock bumpers to face of loading dock in a manner that complies with requirements indicated for spacing, arrangement, and position relative to top of platform and anchorage.

1. Welded Attachment: Plug-weld anchor holes in contact with steel inserts and fillet weld at other locations.
2. Bolted Attachment: Attach dock bumpers to preset anchor bolts embedded in concrete or to cast-in-place inserts or threaded studs welded to embedded-steel plates or angles. If preset anchor bolts, cast-in-place inserts, or threaded studs welded to embedded-steel plates or angles are not provided, attach dock bumpers by drilling and anchoring with expansion anchors and bolts.
3. Screw Attachment: Attach dock bumpers to wood construction with lag bolts as indicated.

END OF SECTION 11 13 00

SECTION 11 30 13 - RESIDENTIAL APPLIANCES

PART 1 – GENERAL

1.1 SUMMARY
- A. Section Includes
  1. Residential appliances.
- B. Related Sections
  1. Section 06 10 00: Rough Carpentry, for concealed in-wall blocking and support backing.
  2. Section 06 20 00 and 06 40 23: Interior Architectural Woodwork, for custom casework in areas associated with residential appliances.
  3. Division 22 and 23: Mechanical, for connections to equipment.
  4. Division 26: Electrical, for power supply, switches and connections to equipment.

1.2 SUBMITTALS
- A. Product Data, including specifications and installation instructions for each type of appliance specified.
- B. Maintenance Instructions: For each type of product installed
- C. Owner's Manual: For each type of product installed

1.3 QUALITY ASSURANCE
- A. Comply with governing codes and regulations.
- B. Certification Labels: Provide appliances that comply with standards and bear certification labels as follows:
  1. Energy Star Ratings: Provide energy guide labels with energy cost analysis (annual operating costs) and efficiency information as required by Federal Trade Commission. All appliances shall meet Energy Star Rating.
  2. Provide D.O.E. labels denoting energy efficiency, attached to each unit.
  3. UL Standards: Provide appliances with UL labels.

1.4 DELIVERY, STORAGE AND HANDLING
- A. Deliver and store appliances in their original containers, with labels intact and legible.
  1. Maintain packaged materials with seals unbroken and labels intact until time of installation.
- B. Do not deliver until finishes in areas of installation are complete and casework or cabinetry has been installed.

1.5 PROJECT CONDITIONS
- A. Coordinate the Work with location and placement of utilities.

1.6 WARRANTY
- A. Provide one year defect-free specialty warranty. Warranty period commences on the date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
- A. Appliances: GE Appliances – see Appliance Schedule at the end of Part 3.
- B. Appliances: Frigidaire Appliances – see Appliance Schedule at the end of Part 3.
- C. Appliances: Bosch Appliances – see Appliance Schedule at the end of Part 3.
- D. Approved Substitutions as reviewed and accepted by the Owner, prior to bid.

2.2 UTILITY SERVICE
- A. As available for building; refer to Work of Divisions 22, 23, and 26 and the Drawings.
- B. All appliances shall be compatible with new building electrical service.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions are ready to receive Work of this Section.
B. Verify blocking and support backing where required for securing units has been placed within wall framing.
C. Verify ventilation outlets, service connections and supports are correct and in required location.
D. Verify that electric power of correct characteristics is available.

3.2 INSTALLATION

A. Install materials and systems in accordance with manufacturer's instructions and approved submittals.
B. Install materials and systems in proper relation with adjacent construction and with uniform appearance.
C. Coordinate with Work of other Sections.
    1. Coordinate location of ventilation and power sources.
    2. Coordinate location of water supply where required.
    3. Coordinate accessible switch locations separate from appliance where specified. See schedule below.

3.3 ADJUSTMENT

A. Adjust appliances and apparatus to ensure proper working order and conditions.
B. Remove and replace appliances creating excessive noise or vibration.

3.4 CLEANING AND PROTECTION

A. Wash and clean appliances prior to Substantial Completion.
B. Remove masking or protective covering from finish surfaces.
C. Polish glass, plastic, hardware, accessories, fixtures and fittings.
D. Protect installed appliances from damage by construction operations.

3.5 DEMONSTRATION

A. Test appliances prior to demonstration.
B. Demonstrate to Owner operation of all appliances.

3.6 APPLIANCE SCHEDULE

Contractor Furnish Contractor Installed Appliances

Item Number		Description	Comments
A.	GE GUD27ESSJSM	Elec Stackable Washer/Dryer	One unit
B.	GE GSS25GGPFS	25.3 Refrigerator (w/ ice maker kit)	Six units
C.	Accucold CP35LLMED	Compact Refrigerator (lockable)	One unit
D.	New Air AL-215SS-BL	Counter Top Ice Machine – ClearIce40	One unit
E.	GE GDT226SSLSS	Undercounter Dishwasher	One unit

END OF SECTION 11 30 13

SECTION 11 53 00 - LABORATORY EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Laboratory Equipment, including but not limited to the following items. Reference drawings and related documents for locations and quantities.
    a. Chemical stores cabinets
    b. Laboratory first aid kits
    c. Laboratory fire blankets
    d. Laboratory ventilated ventilation equipment (fume hood).

1.2 SUBMITTALS

A. Product Data: Provide equipment dimensions and construction, equipment capacities, physical dimensions, utility and service requirements and locations. For each type of product indicated. Include the following:
    1. Construction details and dimensions.
    2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
    3. Material and finish descriptions.
    4. Features that will be included for Project.
    5. Manufacturer's warranty.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
    1. Identify locations using room designations indicated on Drawings.
    2. Identify products using designations indicated on Drawings.

C. Samples: Submit two samples of exposed finish surfaces, 2 x 2 inch in size illustrating color and finish.

D. Manufacturer's Installation Instructions: Indicate special installation requirements.

E. Manufacturer's Certificate: Certify that Products meet or exceed OSHA requirements.

F. Operation and Maintenance Data: For laboratory equipment to include in operation and maintenance manuals. Include description of equipment operation, adjusting and testing required. Identify system maintenance requirements, servicing cycles, lubrication types required and spare part sources.

G. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

A. Requirements: OSHA - Occupational Safety and Health Administration.

B. Source Limitations: Obtain each type of laboratory equipment from single source from single manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store and handle laboratory equipment in a manner to avoid significant or permanent damage to materials.
    1. Accept equipment on site. Inspect on arrival for damage
    2. Comply with manufacturer's written instructions for minimum and maximum temperature requirements for storage.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with equipment, including dimensions and heights of installation area, by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, 0.0312-inch minimum nominal thickness, unless otherwise indicated.

B. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.0359-inch minimum nominal thickness.

C. Galvanized Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.

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

E. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

F. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).

G. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.2 PRODUCTS

A. Chemical stores cabinets

1. Flammables Storage Cabinets: Securall, Product A130
   a. 30 gallon capacity
   b. 2 shelves, 44”x 43”x 18” dimension cabinet
   c. Yellow color
   d. Self-close, self-latch Safe-T-Door
   e. Provide with Polyethylene Tray liners with 1” surrounding lip
   f. Meet applicable OSHA, FM, and NFPA approvals
   g. Quantity: one (1) each, reference drawings for locations
2. Acids Storage Cabinets: Securall, Product C130
   a. 30 gallon capacity
   b. 2 shelves, 46”x 43”x 18” dimension cabinet
   c. Blue color
   d. Self-close, self-latch Safe-T-Door
   e. Provide with Polyethylene Tray liners with 1” surrounding lip
   f. Meet applicable OSHA, FM, and NFPA approvals
   g. Quantity: one (1) each, reference drawings for locations

B. Laboratory first aid kits: Radnor 75 Person Bulk First Aid Cabinet

1. Wall mount sturdy metal first aid cabinet
2. White powder coat finish
3. Standard first aid supply fill for initial stocking of cabinet
4. Quantity: six (6), reference drawings for locations

C. Laboratory fire blankets: Junkin, Product JSA-1000-W

1. Wall mount sturdy metal fire blanket cabinet
2. Red enamel finish, with white lettering
3. 62”x 82” Fire Resistant Treated 100% wool blanket
4. Approximate weight: 3-1/2 pounds
5. Cabinet Dimensions: 23-7/8” long x 8-1/2” wide x 6-1/2” high
6. Quantity: six (6), reference drawings for locations

D. Fume Hood – Kewaunee Supreme Air Fume Hood H09 – Quantity of (3)

1. High performance low velocity bench fume hood with self closing sash
2. Size: 48” tall x 48” wide x 36” deep
3. Base: ADA Steel Base Cabinet 33” tall x 48” width x 22” deep (double door)
4. Line: Phenolic Resin
5. Cupsink: 0490-BE Black Epoxy
6. Panel Flange Valve Fittings: Air, Gas, Vacuum
7. Gooseneck Water Valve: 27” long handle
8. Electrical Fixture: 120v AC receptacle and integral fan switch
9. Coordinate roof exhaust and stainless steel exhaust duct with division 23.

E. Substitutions under provisions of Division 01.

2.3 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

2.4 STEEL FINISHES

A. Galvanizing: Hot-dip galvanize components as indicated to comply with the following:
   1. ASTM A 123/A 123M for iron and steel loading dock equipment.
   2. ASTM A 153/A 153M or ASTM F 2329 for iron and steel hardware for loading dock equipment.

B. Galvanized-Steel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat in manufacturer's standard color.

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 laboratory equipment.

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

3.2 PREPARATION

A. Coordinate size and location of equipment indicated to be attached to or recessed into the building construction, and furnish anchoring devices with templates, diagrams, and instructions for their installation.

3.3 INSTALLATION

A. General: Install laboratory equipment, as required for a complete installation.

B. Follow all manufacturer’s recommendations and requirements for installation of the equipment.

3.4 DEMONSTRATION

A. Provide systems demonstration under provisions of Division 01.

B. Demonstrate equipment operation and safety precautions.

END OF SECTION 11 53 00

DIVISION 12 – FURNISHINGS

SECTION 12 24 13 – ROLLER WINDOW SHADES

PART 1- GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Electrically motor operated window shades.
   2. Manual operated window shades.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.
   2. Division 07 - Joint Sealers: Sealants for perimeter of shade system.
   3. Division 09 – Gypsum Board Assemblies
   4. Division 26 - Electrical supply, conduit, and wiring for motorized skylight shades.

1.2 REFERENCES

A. National Fire Protection Association (NFPA) 701 - Fire Tests for Flame-Resistant Textiles and Films.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Shop Drawings:
      a. Show locations, sizes, relationship to adjacent construction, power supply locations, and other pertinent information.
      b. Mounting details and installation methods.
      c. Power and control wiring diagrams.
      d. Use same room designations as indicated on Drawings.
   2. Product Data: Indicate components, materials, finishes, attachment, and operation.
   3. Storage and handling recommendations.
   4. Samples:
      a. 12 x 12 inch shade cloth samples in each color.
      b. 3 x 3 inch paint samples in each color.
   5. Warranty: As listed below: standard form.

B. Closeout Submittals:
   1. Operation and Maintenance Data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 3 years documented experience in work of this Section.
B. Fabric: Pass NFPA 701 small and large-scale vertical burn tests.
C. Electrical Components: Listed by testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as system.
D. Mockup:
   1. Size: One typical shade unit.
   2. Locate: Coordinate with Architect.
   3. Include window shade, operator and controls, fascia and blackout channels and accessories.
   4. Approved mockup may remain as part of the Work.

1.5 PROJECT CONDITIONS

A. Verify dimensions at site prior to fabrication of shades.
B. Do not install shades until painting and finishing work is complete and ambient temperature and humidity conditions are maintained at occupancy levels.
C. Power and control wiring shall be completed and certified.

1.6 WARRANTIES

A. Furnish manufacturer's warranties providing coverage for:
   1. 10 years against deterioration, sag, and warp of shade cloth.
   2. 5 years against defective hardware.
   3. 5 years against defective motors and controllers.

PART2 - PRODUCTS

2.2 MANUFACTURERS

A. Design Basis: Contract Documents are based on products by MechoShade; Electro Shade System.
B. Equivalent products by following manufacturers are acceptable:
   1. Lutron. (www.lutron.com)
   2. Solarfective Products Limited. (www.solarfective.com)
   3. Solar Shading Systems. (www.solarshadingsystems.com)
   4. Draper Inc. (www.draperinc.com)
C. Substitutions: Under provisions of Division 01.

2.3 MOTOR OPERATED ROLLER SHADE

A. Motor Operated Window Shades:
   1. Power operated shades at all window locations in Commons Room 134.
   2. Operation: Electronic drive unit housed inside head tube.
   3. Shadecloth orientation: Regular rolling with shade cloth falling on window side of roller.
   4. Mounting: Overhead
   5. Head tube: Extruded aluminum.
   6. Fascia: Extruded aluminum.
   7. Blackout channels: Extruded aluminum; side and sill.
   8. Conceal all device boxes and conduits.
B. Shade Cloth:
   1. Fabric hem pocket with RF-welded seams and hem weights concealed in continuous sealed hem pocket.
   2. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling.
   3. Provide battens when required to ensure proper tracking and uniform rolling of shade cloth.
   4. Fabricate shade cloth to completely fill openings from head to sill and jamb-to-jamb, unless otherwise indicated.
   5. Fabricate shade cloth to hang flat without buckling and distortion.
C. Shade Motors: Electronic Drive Unit (EDU)
   1. Intelligent Encoded EDU, and Control System: Tubular, asynchronous (non-synchronous) EDU's, with built-in reversible capacitor operating at 120VAC/60hz, (230VAC/50Hz) single phase, temperature Class B, thermally protected, totally enclosed, maintenance free with line voltage power supply equipped with locking disconnect plug assembly furnished with each EDU.
   2. Quite {42-46 db} (within 3 feet open air)
   3. Conceal EDU's inside shade roller tube.
   4. Maximum current draw for each shade EDU of 0.9amps at 120VAC.
   5. Use EDU's rated at the same nominal speed for all shades in the same room.
   6. Use EDU's with minimum of 34 RPM,that shall not vary due to load/lift capacity.
   7. Total hanging weight of shade band shall not exceed 80 percent of the rated lifting capacity of the shade EDU and tube assembly.
   8. Conceal all device boxes and conduits.
D. EDU System: (software, two-way communication): Specifications and design are based on the Intelligent EDU Control System, WhisperShade IQ System) as manufactured by MechoSystems. Other systems may be acceptable providing all the following performance capabilities are provided. EDU and control systems not in complete compliance with these performance criteria shall not be accepted as equal systems.
   1. EDU shall support two methods of control
      a. Local Dry Contact Control Inputs

i. EDU shall be equipped with dry contact inputs to support moving the EDU/shade to the upper and lower limits.
ii. EDU shall be equipped with dry contact inputs to support moving the EDU/shade to local switch preset positions.
iii. Shall Support configuring the EDU under protected sequences so that a typical user would not change the EDU's setup. At a minimum the configuration should include setting limits, setting custom presets and configuring key modes of operation.

b. Network Control
i. EDU shall be equipped with a bi-directional network communication capability in order to support commanding the operation of large groups of shades over a common backbone. The network communication card shall be embedded into the tubular EDU assembly.

2. Upper and lower stopping points (operating limits) of shade bands shall be programmed into EDU's using either a hand held removable program module/configurator or local switch.

3. Alignment Positions: Each EDU shall support a minimum of 133 repeatable and precisely aligned intermediate shade positions (including limits and presets).
a. All shades on the same switch circuit or with the same network group address with the same opening height shall align at each limit or preset (intermediate stopping position) when traveling from any position, up or down.
b. Shades of differing heights shall have capability for custom, aligned intermediate stop positions when traveling from any position, up or down.
c. Alignment of shades mechanically aligned on the same EDU shall not exceed +/- 0.125 inches (3.175mm) when commanded to the same alignment position.
d. Alignment of shades on adjacent EDU's shall not exceed +/- 0.25" inches (6.35mm) when commanded to the same alignment position.
e. Local Switch Presets: A minimum of 3 customizable preset positions shall be accessible over the local dry contact control inputs and over the network connection.
i. Upon setting the limits for the shade EDU these preset positions shall automatically default to 25%, 50% and 57% of the shade travel.
ii. These positions shall be capable of being customized to any position between and including the upper and lower limits of the shade. A removable program module/configurator or local switch shall be capable of customizing the position of these presets.
f. Network Presets: A minimum of 29 customizable preset positions (including the 3 local switch presets) shall be accessible via network commands.
i. Upon setting the limits for the shade EDU these preset positions shall automatically default to the lower limit unless customized elsewhere.
ii. These positions shall be capable of being customized to any position between and including the upper and lower limits of the shade. A removable program module/ configurator shall be capable of customizing the position of these presets.

4. Network Control
a. The system shall have the capability of two-way digital communication with the EDU's over a common backbone.
b. Each EDU shall possess 8 addresses capable of being employed for various levels of group control. These addresses shall be configurable via a handheld configurator and/or a PC controller. A 9th unique address shall enable the EDU(s) to be independently controlled and configured over the network via a handheld configurator and/or a PC controller.
c. Low Voltage Communication Network Implementation.
i. The low voltage network shall employ a bus topology with daisy chained network connections between nodes over a CAT5 cable (4 UTP) or over a 2 UTP cable employing at least 1 pair at 16 AWG for power and 1 pair at 22 AWG for data.
ii. The low voltage network (+/- 13VDC) shall be powered by the nodes attached to it. These nodes could be line voltage powered EDU's attached to 120 VAC

or 230 VAC. Alternatively, low voltage nodes shall be powered typically by a centralized low voltage power supply. If a CAT5 network cable is employed and the node draws less than 1W then the node may be powered by DC power supplied by an associated line voltage EDU.

iii. Network Capacity: 4000 ft max, 250 nodes max

1. The number and size of a centralized DC supply shall vary depending upon the network requirements.

5. Operating Modes
   a. Uniform or Normal Modes of Operation:
      i. Uniform mode shall allow for shades to only move to defined intermediate stop positions to maintain maximum uniformity and organization.
      ii. Normal Mode shall allow for shades to move to both intermediate stop positions, plus any position desired between the upper and lower limits as set by the installer.
6. Wall Switches:
   a. Shades shall be operated by, 5, 7, or 10 button low voltage standard switches, or programmable intelligent switches (IS). Standard switch shall be wired to a bus interface and the bus interface will be programmed to transmit an address for the local switch.
   b. Intelligent switches may be installed anywhere on the bus line. Each IS shall be capable of storing one control level address to be broadcast along the bus line.
   c. An address that is transmitted by either a switch or central controller shall be responded to by those EDU's with the same address in their control table.
   d. IS shall provide for interface with other low voltage input devices via a set of dry contact terminals located on the switch.
   e. Standard switch or IS may control an individual, sub-group or group of EDU's in accordance with the address in each EDU.

E. Accessories:
1. Extruded aluminum fascia, removable. Fully conceal brackets, roller and fabric.
2. Room darkening side and sill channels with concealed fasteners to accept blackout hembar with vinyl seal.

2.4 MANUALLY OPERATED ROLLER SHADE

A. Manual Window Shades
1. Operation: Manual (down configuration) at window and site lites – reference drawings.
a. Shadecloth orientation: Regular rolling with shade cloth falling on window side of roller.
2. Mounting: End Brackets. Recess roller assembly into window cavity.
3. Head tube: Extruded aluminum.
4. Fascia: Extruded aluminum.
5. Blackout channels: Not Used.

B. Shade Cloth:
1. Fabric hem pocket with RF-welded seams and hem weights concealed in continuous sealed hem pocket.
2. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling.
3. Provide battens when required to ensure proper tracking and uniform rolling of shade cloth.
4. Fabricate shade cloth to completely fill openings from head to sill and jamb-to-jamb, unless otherwise indicated.
5. Fabricate shade cloth to hang flat without buckling and distortion.

C. Manual Operator:
1. Overrunning clutch, large diameter sprocket and self-lubricating components.

2.5 FINISHES

A. Fabric: Extra - Dense Linear Weave "0900 series", 0-1 percent visually translucent linear weave pattern. Color to be selected from manufacturer's full color range.

B. Aluminum: Baked enamel, color to be selected from manufacturer's full color range.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that openings are ready to receive the work.
B. Ensure structural blocking and supports are correctly placed.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 Turn-Key Responsibility for Interior Roller Shades: To control the responsibility for performance of the electric roller shade system; assign the design, engineering and installation of electronic drive roller shade control system, shades, addressable controls, communication interfaces and any required sensors and switches specified in this Section to the manufacturer of the shade and control systems.

A. Window Covering Subcontractor (WC) Responsibilties:
    1. WC will provide J-Box leads, Splitters, Sensors and communication interfaces (if required) to the General Contractor/Electrical Subcontractor.
    2. Locations for all visible devices to be coordinated with Architect.
    3. The shade control subcontractor shall inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

B. General Contractor Responsibilities:
    1. Provide power panels and circuits of sufficient size to accommodate roller shade manufacturer's requirements, as indicated on the mechanical, electrical drawings and manufacturer's shop drawings.
    2. Coordinate with requirements of subcontractor for this section before inaccessible areas are constructed.
    3. Coordinate with Electrical Contractor (EC) to provide line voltage, conduit and low voltage wiring to locations specified by drawings. Conceal all device boxes and conduits. Surface mounted conduits are not allowed.
    4. Coordinate with Window Covering Subcontractor (WC) to receive items provided by subcontractor for coordination with the Electrical Contractor (EC).
    5. Verify that wiring conditions which have been previously installed under other sections or at previous time, are acceptable for product installation in accordance with manufacturer's instructions.
    6. Comply with manufacturer's product data, including ship drawings, technical bulletins, product catalog installation instructions and product carton instructions for installation.
    7. Protect installed product and finished surfaces from damage during all phases of installation including preparation, testing and cleanup.
    8. Be responsible for all other required electrical work including but not limited to roof penetrations, conduits, fireproofing, etc.
    9. Provide conduit with pull wire in all areas, which might not be accessible to subcontractor due to building design, equipment location or schedule.
    10. Provide blocking where required for shade mounts. Minimum of 16ga steel or ¾" FR plywood. Blocking for roller shades installed under the contract of the interior General Contractor shall be installed plumb, level and fitted to window mullion as per interior architect's design documents and in accordance with industry standard tolerances. The horizontal surface of the shade pocket shall not be out of level more than 0.625 inch (15.875mm) over 20 linear feet (6.096 meters).

C. Electrical Contractor (EC) Responsibilities:
    1. Coordinate items provided by the WC (J-Box leads, Splitters, Additional Sensors and Communication Interfaces) for installation in compliance with local jurisdictional requirements.
    2. Furnish and install line voltage cable from roller shade motor into line voltage side of control system.

3. Shall wire from General Contractor, provided, power junction box to each motor on the shade network.
4. Shall install a disconnect plug at the end of the power wiring run to each EDU. The disconnect plug must mate with a matching disconnect plug on the motor cable. EDU cable disconnect plug must be prefabricated by the manufacturer to meet UL and ETL systems requirements to be provided by the WC to EC.
5. Limitations on the system as required for shade products:
    a. RS232 connections – Max distance between connections 25'-0" cable feet
    b. RS485 connections – Max distance between connections 45'-0" cable feet with a maximum of 250 devices. Maximum of 4000' cable feet.
    c. Low voltage connections to be in compliance with USOC standard. Test each cable in the network with a low voltage tester before turning over to WC.

D. Integration with Third Party Systems:

1. Main Contractor shall coordinate and provide for others to furnish, install or program any interfaces or wiring to integrate 3rd party systems to the roller shade control system as specified herein. Integration to shade control network can be accomplished locally through dry contract closures, or RS-232.

3.4 INSTALLATION OF ROLLER SHADES

A. Contractor Furnish and Install Responsibilities:

1. Window Covering Contractor (WC) to attend Pre-Con meeting as well as any subcontractor meetings required to coordinate the work.
2. WC shall supervise the roller shade installation and setting of intermediate stops of all shades to assure the alignment of the shade bands within a single EDU group, which shall not exceed +/- 0.125 inches (6.35mm),
3. WC shall be responsible for field inspection on an area-by area and floor-by-floor basis during construction to confirm proper mounting conditions per approved shop drawings.
4. Verifications of conditions: examine the areas to receive the work and conditions under which the work would be performed and notify General Contractor and Owner of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected in that area.
5. WC shall provide accurate to 0.0625 inch (1.5875mm); field measurements for custom shade fabrication on the Roller Shades manufacturers input forms.
6. WC Installer shall install roller shades level, plumb, square and true according to manufacturer's written instructions and specified here in.
7. Shades shall be located so the shade band is not closer than 2 inches (50 mm) to the interior face of the glass. Allow proper clearances for window operation hardware.
8. Adjust, align and balance roller shades to operate smoothly, easily, safely and free from binding or malfunction throughout entire operational range.
9. Installer shall set Upper, Lower and up to 3 intermediate stop positions of all motorized shade bands, and assure alignment in accordance with the above requirements.
10. WC shall certify the operation of all motorized shades and turn over ach floor for preliminary acceptance.
11. The WC shall participate and cooperate with the electrical contractor, the window shade manufacturer and the Commissioning agent to verify and certify the installation is in full conformance with the specifications and is fully operational. This work to occur during the commissioning stage and is in addition to preliminary acceptance required for each floor.
12. Clean roller shades surfaces after installation, according to manufacturer's written instructions.

B. Secure in place with flush countersunk fasteners

3.5 ADJUSTING

A. Adjust shades for smooth, quiet operation.

3.6 SCHEDULE

A. Provide power operated shades full height and full width of windows in the Commons area. Shade assembly shall be recessed into window frame cavity and operate in unison over entire wall plane. Conceal all power and control pathways within curtain wall framing. Reference sheet A6.01.

B. Provide manual operated shades full height and full width of all interior/exterior windows and door side lites. Shade assembly shall be recessed into window frame cavity and operate individually at each location. Reference sheet A6.01.

END OF SECTION 12 24 13

SECTION 12 93 00 – SITE FURNISHINGS

PART 1 – GENERAL

1.1 SUMMARY
- A. Section includes:
  1. Bike Rack
  2. Skateboard Rack
  3. Bollards

1.2 SUBMITTALS
- A. Bike and Skateboard Rack Product Data: Provide data on rack accessories and configurations.
- B. Bike and Skateboard Rack Samples: Submit two samples 4 x 4 inch in size illustrating material, color and finish.
- C. Bollards: Provide data cut sheet on bollards illustrating material, color and finish.

1.3 QUALITY ASSURANCE
- A. Spiral wrap bike and skateboard racks with protective covering and pack in protective shipping tubes or containers.
- B. Protect bike and skateboard racks and accessories from damage.

PART 2 PRODUCTS

2.1 BIKE RACK
- A. Bike Rack: Bike loop (ASTM A53/A500) schedule 40 steel pipe (2.375" OD x .154 wall), hydraulically bent with a mandril and hot-dipped galvanized after fabrication by Ribbon Racks Model No. RB11, Metal Specialties MS11, Dero Rolling Rack RR5H, or approved equal.

2.2 SKATEBOARD RACK
- A. Brute 12 Short Skateboard Rack: Shall be powder coated ¼" mild steel plate with locking 12 skateboard holding capacity as manufactured by Loch Unlimited or approved.

2.3 BOLLARDS
- A. Decorative Bollard: Shall be 12-Inch Dia. R-7535 Decorative Bollard, Classic Column without handle manufactured by Reliance Foundary or approved equal and as shown in Drawings.
- B. Standard Bollard: Shall be 6-Inch Dia. schedule 40 steel pipe filled with concrete, painted safety yellow and as shown in Drawings.

PART 3 EXECUTION

3.1 EXAMINATION
- A. Verification of existing conditions before starting Work.
- B. Verify gradients and elevations of base are correct.

3.2 BIKE AND SKATEBOARD RACKS
- A. Install bike and skateboard rack assembly and fittings in accordance with manufacturer's guidelines and instructions.
- B. Install bike and skateboard racks plumb and level and as shown in the Drawings.

3.3 BOLLARDS
- A. Install bollards in accordance with manufacturer's guidelines and instructions and as shown in the Drawings.

END OF SECTION 12 93 00

12 93 00 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes all site furnishings associated with this project, including but not limited to:
   1. Bike Racks
   2. Vehicular Gate
   3. Concrete Block Fence Wall
   4. Basketball goals
   5. Pickleball posts and net (bid alternate 6)
   6. Removeable volleyball posts and net (part of bid alternate 8)

B. Related sections include the following:
   1. Division 32 Section “Synthetic Turf” for volleyball post sleeves and volleyball court striping
   2. Division 32 Section “Acrylic Surfacing” for pickleball and basketball surfacing and striping

1.2 REFERENCES

A. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2000.

B. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2000.

C. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2000.

D. ASTM A 325M - Standard Specification for High-Strength Bolts for Structural Steel Joints (Metric); 2000.

E. ASTM A48 – Standard Specification for Gray Iron Castings.

F. AWS D1.1 - Structural Welding Code - Steel; American Welding Society; 2000.

1.3 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product specified, including detailed installation diagrams and recommended installation methods.

B. Selection Samples: For each product specified, two complete sets of chips representing manufacturer's full range of colors and finishes.

C. Steel Vehicular Gate:
   1. Contractor to provide shop drawings detailing concrete post footing and reinforcement.
   2. Contractor to provide structural calculations for concrete footing and reinforcement.

1.4 QUALITY ASSURANCE

A. Furnish paint for touch-up as required.

B. Install pre-manufactured items, poured-in-place or pre-cast items, and all related materials required to complete the work indicated on the drawings and/or specified.

C. Materials Inspection: The Contractor shall inspect all items upon delivery to ensure no damage to material or finish. Minor repairs and/or touch up shall be accepted only upon prior authorization from the landscape architect and shall conform, at minimum, to manufacturer's standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Substitutions or equivalent products shall be in accordance with Division 01 and shall be submitted for consideration prior to bidding.

2.2 SITE FURNISHINGS

A. Bike Rack: Location as shown on plan sheets, surface mount. Classic Bike Rack (10 bike), product number CL1-10. Color: black powder coat finish. By Sitescapes 402-421-9464 www.sitescapesonline.com.

B. Vehicular Gate: Location as shown on plans. Gate: Sentinel 32' Manual Double Swing Barrier Gate, in-ground installation. Part number 14020-32. By Tigerteeth 800-787-7829 tigerteethstore.com.
1. Before ordering, contractor to verify that 32' wide gate will fit new driveway as built.

C. Concrete Block Fence Wall: Location as shown on plans. Western Materials Split-face Fence block, and Fence Pilaster block. Color(s) to be chosen by Pasco School District during construction. Install per City of Pasco Building Division "Typical Wedge Lock Fence Plan" detail. 509-543-5726

D. Basketball goals: Location as shown on plan sheets. BA871-BK Ultimate Playground Basketball System. By Bison 800-247-7668 www.bisoninc.com.
1. Embed mount goals per manufacturer specifications.

E. Pickleball posts & net (bid alternate 6): Location as shown on plan sheets. PK10XL Competition Pickleball System. By Bison 800-247-7668 www.bisoninc.com.
1. Embed mount posts per manufacturer specifications.

F. Removeable volleyball posts and net (part of bid alternate 8): Location as shown on plans. SVB2000A Aluminum Recreational Volleyball System. Install posts in sleeves VB21 for removability. By Bison 800-247-7668 www.bisoninc.com.
1. See Section 32: "Synthetic Turf" for sleeve installation specifications

2.3 FABRICATION

A. Shop assemble site furnishings for delivery to site in units easily handled and to permit shipment

without disassembly.

2.4 ACCESSORIES

A. Provide all anchorage devices and materials required for a complete installation.

PART 3 -EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Landscape Architect of unsatisfactory preparation before proceeding.

3.2 INSTALLATION

A. Install all site furnishings in accordance with manufacturer's instructions.

B. Concrete work shall conform to structural concrete specifications. Proper lines and grades are essential.

C. Assemble, as required, for complete operation in strict conformance with manufacturer’s requirements. Notify landscape architect in the event of any discrepancies.

D. Install as shown on the drawings and in strict conformance with manufacturer’s recommendations.

E. Touch-up paint, as necessary, all blemishes incurred during shipping or assembly, color as designated, to manufacturer’s standards.

F. Bike rack
   1. Surface mount to concrete paving with ½” x 4-5” stainless steel anchor bolts, per manufacturer recommendation.

3.3 ADJUSTING

A. Upon completion of the installation of site furnishings, check each item and verify that all equipment is properly installed; verify that all trim is in place; adjust all components as necessary to ensure proper operation; remove all labels from equipment.

B. Make necessary adjustments for safe, efficient and smooth operation.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products after Substantial Completion.

3.5 CLEANING

A. Remove all packing materials from job site.

B. Clean or restore marred surfaces.

3.6 WARRANTY

A. Contractor shall warrant work as provided by the General and Supplementary Conditions and Division 01 Specifications.

END OF SECTION 12 93 00

DIVISION 13 – SPECIAL CONSTRUCTION

SECTION 13 21 68 – SECURITY TRANSACTION WINDOW

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Bullet Resistant Transaction Window Assembly.

1.2 RELATED SECTIONS
A. Section 06 10 00 - Rough Carpentry
B. Section 06 40 23 – Interior Architectural Woodwork
C. Section 08 70 00 - Hardware
D. Section 08 81 00 - Glass

1.3 REFERENCES
A. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar.
B. ASTM B 209/B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
C. NIJ Standard 0108.01 - (National Institute of Justice) Standard for Ballistic Resistant Protective Materials.
D. Underwriters Laboratories: UL 752 - Standard for Bullet Resisting Equipment.

1.4 PERFORMANCE REQUIREMENTS
A. Design, fabricate and install all partition materials specified in this section to meet or exceed the requirements of UL 752.

1.5 SUBMITTALS
A. Submit under provisions of Section 01 60 00.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.
C. Shop Drawings: Submit Manufacturer approved shop drawings detailing plan, section and elevation views as necessary to ensure proper field installation procedures. Coordinate locations with those listed in the Contract Drawings.
D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
E. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.

1.6 QUALITY ASSURANCE
A. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of five (5) years' experience.
B. Installer Qualifications: All products listed in this section are to be installed by a single installer with a minimum of five (5) years demonstrated experience in installing products of the same type and scope as specified.
C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
1. Finish areas designated by Architect.
2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
3. Refinish mock-up area as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer's unopened packaging until ready for installation.
B. Store and dispose of hazardous materials, and materials contaminated by hazardous materials,

in accordance with requirements of local authorities having jurisdiction.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 WARRANTY

A. At project closeout, provide to Owner or Owners Representative an executed copy of the manufacturer's standard limited warranty against manufacturing defect, outlining its terms, conditions, and exclusions from coverage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Total Security Solutions, which is located at: 170 National Park Dr.; Fowlerville, MI 48836; Tel: 517-223-7807; Web:www.tssbulletproof.com
   1. Basis-of-Design: Total Security Solutions
B. Model: Aluminum Sliding Transaction Window
C. Size: 60 inches wide by 78 inches tall, see drawings.
D. Accessories: Aluminum Frame, counter, recessed transaction tray, lockable.
E. Rating: Bullet Resistant Level 2
F. Quantity: Two Units
G. Substitutions requests in accordance with provisions of Section 01 60 00.

2.2 COMPONENTS

A. Glazing: Bullet Resistant Glazing:
   1. Glazing Type: Laminated acrylic/polycarbonate composite.
   2. Rating: UL 752 Level 2.
   3. Glazing Thickness: 1 3/8 inch (35mm).
   4. All panels finish above the teller riser. Reference drawings.
B. Aluminum Sections: Extruded aluminum alloy 6063 T5 manufactured in accordance with ASTM B209. Anodized or powder coated finish to match the existing decor and be free of sharp edges or burrs when in place.
   1. Glazing Channel: U-Channel specifically designed for securing transparencies tightly in place. Angles and stops are only acceptable for top attachment.
   2. Door Frames: 1 3/4 inch by 4 inches by 1/8 min. (44mm x 102mm x 3mm) wall thickness. Anodized or powder coated finish to match the existing decor and be free of sharp edges or burrs when in place.

2.3 BULLET RESISTANT TRANSACTION MODULES

A. Construction:
   1. Model: Interior Horizontal Slider.
   2. Rating: UL 752 Level 2.
   3. Frame: Aluminum tube and fixed glazing channel. Glazing is wrapped with anodized aluminum channels.
   4. Counter Construction: Stainless Steel, No. 4 Brushed Finish.
   5. Deal Tray: Stainless steel - recessed.
   6. Hardware: Schlage Keyway, fully secure transaction window
B. Glazing: As specified in Article 2.2 of this section. Meets Underwriters Laboratories Standard 752 for bullet resistance and/or tested by H.P. White Laboratory for specified bullet resistance.
   1. Glazing Type: Monolithic acrylic.
   2. Full Vision Doors
   3. Lockset: Schlage D80PD.

2.4 CURRENCY TRAYS

A. Mounting: Recessed with Bullet Trap.

1. Dimensions: 14 inches by 13 inches by 2-1/2 inches (356mm x 330mm x 64mm).

B. Finish:
1. Finish: Brushed Stainless Steel.

2.5 PACKAGE PASSERS
A. Not Used.

2.6 STRUCTURAL SUPPORTS
A. Where installation requires lateral bracing, locate braces no wider than 96 inches (2438mm) on centerlines. The depth of the brace below the counter and vertical support (brace) above the counter must maintain a ratio of at least 20 percent of the total installation height.
B. Install 1 1/2 inch (39mm) square steel tube braces below the counter and hoods with a minimum wall thickness of 1/8 inch (3mm). Welded in place and include two vertical and horizontal members. Bolt or weld a diagonal member between the two horizontal members.
C. Extend braces located above the counter and hoods to the top of the acrylic slotted jump shield. Material to be of the specified bullet resistant material. At no time shall the vertical supports be less than 10 inches (254mm) in depth.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Do not begin installation until substrates have been properly prepared.
B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION
A. Clean surfaces thoroughly prior to installation.
B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION
A. Install in accordance with manufacturer's instructions.

3.4 PROTECTION
A. Protect installed products until completion of project.
B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 13 21 68

SECTION 14 24 00 - HYDRAULIC ELEVATORS – PASSENGER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes.

1. Hole-less Front Mounted Jack Elevators
2. Passenger cab with doors and frames; hoistway entrance doors and frames.
3. Guide rails, brackets, pit buffers, safety top rail and other related accessories and equipment.
4. Machines, controllers, hoistway, equipment, and accessories. Motors, pumps, piping, controls and wiring from controller. The elevator installation contractor shall include all mechanical & electrical connections for a complete and operating system.
5. Guide rail bracket inserts provided by Elevator Contractor and installed by General Contractor.
6. Sills provided by this Section, grouted into place by Contractor.
7. Verify conditions, obtain elevator installation permit, and provide all current accessories required by State L&I use permit.
8. Non-proprietary controller, phone, operations and maintenance system.

B. System Description.

1. Characteristics of elevator are as follows: Hydraulic Passenger Elevator System.

a.	Rated Net Capacity	2,500 lbs.
b.	Rated Speed	100 ft/min. Single Speed
c.	Nominal Platform Size	6’-8” wide by 4’-3” deep
d.	Operation:	Single Car
e.	Hoistway and Cab Entrance:	As selected from manufacturer standard options
f.	Door Operation:	Horizontal sliding, single slide
g.	No. of Stops:	(2) Two
h.	No. of Openings:	(2) Two (Front)
i.	Power Supply:	3 Phase - 60 cycles; 208V or 480V. Verify voltage requirements with electrical one-line diagram.
j.	Machine Location:	Adjacent to hoistway
k.	Travel:	+/- 14 feet, field verify
l.	Door Operation:	D.C. powered automatic
m.	Car Enclosure:	Laminated Plastic
n.	Special Features:	In Car direction lanterns/chimes Design for Seismic Zone 2 Emergency car lowering device Fire Service, Required Signage Features for Accessibility ANSI A 117.1, Number 4 Stainless Steel Hall Fixtures, ANSI A 117.1 Phone Exhaust fan with keyswitch One set of elevator pads
o.	Hoistway Frames/Doors:	Stainless Steel finish
p.	Short Circuit Current Wiring	10,000Amps minimum

2. Elevator and Door Control Features:

A. Provide coordination and connection between elevator operation and building electronic access / security control system. Provide all necessary connections, relays and programming to allow for

Owner's access control system. Controller and phone shall be non-proprietary and operational by any elevator maintenance service provider.

B. Program doors to open automatically when car arrives at floor.

C. Render "Door Close" signal inoperative when car is standing at dispatching terminal with doors open.

D. If doors are prevented from closing for approximately ten seconds because of and activated obstruction safety device, automatically disconnect door reopening device, close doors more slowly until obstruction is cleared. Sound buzzer.

E. Door Safety Devices: Movable, retractable safety edges, quiet in operation; equip with photo-electric light rays.

F. Keyed and key-card access control with switch at each elevator landing with vandal resistant call buttons. Coordinate elevator remote access with building system and building controls.

3. Interconnect elevator control system with electronic access control and building smoke alarm system. Connection shall be made in elevator machine room. Wiring to machine room by Division 26.

4. Provide emergency communications per ANSI A117.1 standards.

5. Jack Unit: The jack unit shall be of sufficient size to lift the gross load the height specified and shall be factory tested to insure adequate strength and freedom from leakage.

6. Car Enclosure Railing: Provide standard steel safety railing on the outside perimeter of the car enclosure top on all sides where 12 inch void or greater occurs at edge of the car enclosure top and the adjacent hoistway enclosure and at locations where there is no hoistway enclosure. Conform to ASME A17.1.

7. Provisions for Handicapped.

A. Comply with ANSI A117.1

B. Provide indicators near controls in conformance with ANSI A117.1.

C. Landing Buttons: Stainless steel, illuminating type, one for originating UP and one for originating DOWN calls, one button only at terminating landings; marked arrows, including indications required by ANSI A117.1

D. Locate highest button in elevator cab control panel and the center of the accessible telephone, not more than 54" above floor level.

E. Hand Rails: To comply with ANSI A 117.1.

F. Sound audible tone signal in car when car is stopping at a floor or passing a floor.

G. Include with car riding lanterns, audible tone signals; once for UP stops and twice for DOWN stops.

H. In each cab provide Arabic numerals 5/8 inch in height raised 0.03 inch Braille numerals immediately to left of floor buttons to identify floor.

I. At each floor landing provide 2 inch floor numerals raised 0.03 inch on door frame jamb.

J. Include Emergency Communications System to meet ANSI A 117.1 requirements.

8. Provide fully non-proprietary controller, phone, operations and maintenance system, allowing any qualified vendor to provide future maintenance service contract to Owner.

1.2 REFERENCES

A. ANSI A117.1 - Standards for Accessibility.

B. ASME A17.1 - Safety Code for Elevators and Escalators.

C. ASME A17.2 - Inspector's Manual for Elevators and Escalators.

D. AWS D1.1 - Structural Welding Code, Steel.
E. NFPA 70 - National Electrical Code.
F. NFPA 80 - Fire Doors and Windows
G. UL 10B - Fire Tests of Door Assemblies.
H. NEMA MG1 - Motors and Generators.
I. IBC 2015 – Chapter 30 Elevators and Conveying Systems
J. AISC (American Institute of Steel Construction).

1.3 SUBMITTALS

A. Elevator and Electrical Shop drawings: Indicate the following information:
1. Driving machine, controller, motor generator, selector, governor, and other component locations.
2. Car, guide rails, buffers, and other components in hoistway.
3. Rail bracket spacing and maximum loads imposed on guide rails requiring load transfer to building structural framing.
4. Individual weight of principal components; load reaction at points of support
5. Clearances and over travel of car.
6. Location of components in machine room.
7. Locations in hoistway and machine room of traveling cables and connections for car light and telephone.
8. Location and size of access doors, doors and frames.
9. Expected heat dissipation of elevator equipment in machine room.
10. Interface with building security system.
11. Electrical characteristics and connection requirements.
12. Show arrangement of equipment in machine room so that equipment can be removed for repairs or replaced without disturbing other components. Allow for equipment to clear passage through access door.

B. Product Data: Provide product data on the following items:
1. Signal and operating fixtures, operating panels, and indicators.
2. Cab design, dimensions, layout and components.
3. Cab and hoistway door and frame details.
4. Electrical characteristics and connection requirements.

C. Operation and Maintenance Data.
1. Submit under provisions of Division 01.
2. Include all parts catalogs with complete list of equipment replacement parts; identify each entry with equipment description and identifying code. Provide technical information for servicing operating equipment.
3. Include legible schematic wiring diagrams of installed electrical equipment, and changes made in the Work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.
4. Provide one copy of master schematic and one copy of lubrication chart, each framed with clear plastic; mount on machine room wall.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ASME A17.1, AWS D1.1, NFPA 70, AISC, and as supplemented in this section.
B. Fabricate and install door and frame assemblies in accordance with NFPA 80 and UL 10B.
C. Qualifications
1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

D. Regulatory Requirements.
1. Conform to applicable code for manufacture and installation of elevator system.
2. Conform to ANSI A117.1 for provisions for the physically handicapped.
3. Products Requiring Electrical Connection: Listed and classified by testing

firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

E. Pre-Installation Conference
   1. Convene one week prior to commencing work of this section, under provisions of Division 01.
   2. Require attendance of persons directly involved with the work of this section.
   3. Review schedule of installation, installation procedures and conditions, and coordination with related work.

1.5 PROJECT/SITE CONDITIONS

A. Field Measurements.
   1. Verify that field measurements are as instructed by the manufacturer prior to the construction of pit and shaft walls.

1.6 MAINTENANCE

A. Furnish service and maintenance of elevator system and components for one year from date of Substantial Completion.

B. Examine system components monthly. Clean, adjust, and lubricated equipment.

C. Include systematic examination, adjustment, and lubrication of elevator equipment; maintain hydraulic fluid levels. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment. Replace wire ropes when necessary to maintain the required factor of safety.

D. Perform work without removing cars during peak traffic periods.

E. Provide emergency call back service during working hours for this maintenance period.

F. Maintain locally, near the Place of the Work, an adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure the fulfillment of this maintenance service, without unreasonable loss of time.

G. Perform maintenance work using competent and qualified personnel, under the supervision and in the direct employ of the elevator manufacturer or original installer.

H. Maintenance service shall not be assigned or transferred to any agent or Subcontractor without prior written consent of the Owner.

I. Maintain entire elevator installation for 12 months after date of Substantial Completion of Work.

J. Include systematic examination, adjustment and lubrication of elevator equipment, repair or replace worn electrical and mechanical parts of the elevator equipment using only genuine standard parts produced by manufacturer of equipment concerned.

K Replace seals, packing, and valves to maintain required factor of safety.

L. Perform work without removing cars during peak traffic periods.

M. Provide 24 hour emergency call back service during maintenance period.

N. Ensure that competent personnel handle maintenance service. Maintain locally an adequate stock of parts for replacement or emergency purposes and have qualified personnel available at such places to ensure the fulfillment of this service without unreasonable loss of time.

1.7 WARRANTY

A. Special Warranties: Manufacturer and installer of elevator installed agrees to repair or replace elevator that fail in materials or workmanship within specified warranty two-year period. Special Warranty shall include: labor, materials, freight, shipping, maintenance, equipment, tools on all failing parts.

1. Elevator: Two-year warranty.

PART 2

PART 3 - PRODUCTS

3.1 MANUFACTURERS

A.	Basis of Design: Schindler Elevator	330A Holeless Hydraulic General Purpose, Dual Jack, Front Opng
B.	Kone Elevator Model:	Approved Equal
C.	Otis Elevator Model:	Approved Equal
D.	Or approved equal under 01 60 00 provisions	

3.2 COMPONENTS

A. SIGNALS: Light-up pushbuttons in car and hall. Digital position indicator in car.

B. SPECIAL FEATURES: Control station location, tactile labeling of buttons and door jambs, photo-electric door protection and car riding lantern per ANSI-A117.1. Car control station mounted in swing-out return panel to eliminate separate faceplates. Emergency lighting per Code. Fire Service per ASME A17.1. Platform and sling designed for "Class A" freight loading. Electronic passenger sensing device. Protection pad button, ANSI A117.1 accessible telephone instrument with auto dialer. Provide emergency alarm bell properly located within building and audible outside hoist ways, equipped to sound automatically in response to emergency stops and in response to “Alarm” button on each car control station. An intercom shall be provided and installed by the elevator contractor to comply with Washington State Code.

C. CAR: 8'-0" high paneled cab with fan, emergency car light, telephone cabinet;

D. ENCLOSURE: wall and ceiling finish as specified.

E. WALLS: Wood-core construction with plastic Laminate on inside as selected from manufacturer's standard patterns and laminate backing and fire-retardant paint outside. Assemblies shall be constructed with binder containing no urea formaldehyde, and complying with the VOC limits defined in section 01 84 14.

F. CANOPY: Unitized Steel Construction with escape hatch per Code.

G. FRONT & TRANSOM: No. 4 Stainless steel. Door column and return panel to be integrally formed from one sheet and hinged for access to controls without separate faceplates.

H. DOORS: No. 4 Stainless Steel over steel.

I. DOOR FRAME: Hollow metal door frame assembly fabricated from cold-rolled steel sheet, 16 gauge- thick, to be rigid and free of defects, warp, or buckle.

J. CEILING: Full-coverage suspended ceiling with manufacturer's standard diffuser panels under fluorescent lighting.

K. FLOOR FINISH: Carpet roll with Class I fire rating as measured by ASTM E 648. Carpet style, pattern and color to match other areas of the building.

L. SILL: Extruded aluminum assembly coordinated with adjacent floor system.

M. HANDRAIL(S): No. 4 Cylindrical Stainless Steel segmented on 3 walls.

N. TELEPHONE CABINET: Box with stainless steel cover in swing return. (Communication instrument by elevator installer programmed to be monitored at a local 24 hour service.) Elevator contractor will provide a telephone communication system that complies with ADAAG Section 4.10.14 and ASME A17.1, 1990 Rule 211.1. The phone shall be a hands-free, vandal-resistant type with indicator light to inform the person in the car when the call is answered and assure that help is on the way. The system shall include an automatic dialer that is programmable from a remote location. The phone shall bear the ADA-required raised letter and Braille identification.

1. Provide and install as part of this system, a base station at an answering location, which automatically identifies the location of the caller.
2. The phone shall have the capability to remain live for a fixed time or until the answering party hangs up. The phone shall also be capable of dialing two different numbers prioritized by the Owner.
3. Provide a standard RJ11 modular plug-in jack in the elevator machine room and a touch-tone dedicated outside phone line.
4. Telephone system shall be non-proprietary and operational by any elevator

maintenance service provider

O. SMOKE DETECTORS: Provide in the elevator machine room, in the hoistway, and at all elevator landings. The smoke detectors will be connected to the elevator controller and will initiate “Fire Service”, elevator recall.
1. For buildings without fire alarm systems, the smoke detectors will be independent of any fire system in the building and installed by the elevator contractor. The power for the smoke detectors shall be provided by the elevator contractor from circuits available in the elevator.
2. For buildings with addressable fire alarm systems, fully integrate the smoke detectors with the fire alarm system and comply with NFPA 72 standards.

3.3 ACCESSORIES
A. Flooring: Carpet Flooring by Division 09.

PART 4 - EXECUTION

4.1 EXAMINATION
A. Verify that hoistway, pit, and machine room as shown in drawings and this specification are compatible with selected elevator provider. Verify pit depth, width, length and height prior to pouring concrete foundation.
B. Verify shaft and openings are of correct size and within tolerances prior to construction.
C. Verify location and size of machine room prior to ordering elevator equipment.
D. Verify that electrical power is available and of correct characteristics.

4.2 PREPARATION
A. Arrange for temporary electrical power by General Contractor to be available for installation work and testing of elevator components.

4.3 INSTALLATION
A. Install in accordance with ASME A17.1.
B. Install system components. Connect equipment to building utilities.
C. Provide conduit, boxes, wiring, and accessories.
D. Mount machine in accordance with Seismic requirements for the project location.
E. Accommodate equipment in space indicated by General Contractor, maintaining minimum clearances to meet electrical code.
F. Install guide rails using threaded bolts with metal shims and lockwashers under nuts. Compensate for expansion and contraction movement of guide rails.
G. Accurately machine and align guide rails. Form smooth joints with machined splice plates.
H. Bolt brackets to self drilling expansion shell anchors that will perform to four times the rated pull-out load.
I. Field Welds: Chip and clean away oxidation and residue; wire brush weld; spot prime with two coats.
J. Coordinate installation of hoistway wall construction.
K. Install hoistway door sills, frames, and headers in hoistway walls. Grouting of sills by Section 03 30 00. Set entrances in vertical alignment with car openings and aligned with plumb hoistway lines.
L. Adjust equipment for smooth and quiet operation.
M. Coordinate key-card access control and switch at each floor landing with building low-voltage systems.
N. Tolerances.
1. Guide Rail Alignment: Plumb and parallel to each other within 1/8 inch in accordance with ASME A17.1. and ASME A17.2.
2. Cab Movement on Aligned Guide Rails: Smooth movement, with no objectionable lateral or oscillating movement or vibration.

4.4 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 01.
B. Perform tests required by ASME A17.2.
C. Provide two weeks written notice of date and time of tests.
D. Supply instruments and execute specific tests.
E. Inspection
   1. Obtain and pay for inspections and permits and make such tests as are required by regulations of authorities. Make tests in presence of Architect/Engineer.
   2. Final inspection shall be after elevator installation, hoisting enclosure and machine room are complete.
   3. Inspect Installation in accordance with ASME A17.2
   4. Deliver test certificates and permits to Architect/Owner for final payment.

4.5 ADJUSTING

A. Adjust work under provisions of Division 01.
B. Adjust for smooth acceleration and deceleration of car to provide passenger comfort.
C. Adjust automatic floor leveling feature at each floor to achieve an alignment of cab floor and landing floor within 1/4 inch from flush.

4.6 CLEANING

A. Clean work under provisions of Division 01.
B. Remove protective coverings from finished surfaces.
C. Clean surfaces and components ready for inspection.

4.7 PROTECTION OF FINISHED WORK

A. Protect finished Work under provisions of Division 01.
B. Do not permit construction traffic within cab after cleaning.

END OF SECTION 14 24 00

DIVISION 21 – FIRE SUPPRESSION

SECTION 21 10 00 - FIRE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all materials, labor, equipment design and services necessary to perform the installation of the fire protection system as shown on the drawings and as described herein.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Sections, apply to work of this section.

B. The following Sections contain requirements that apply to portions of this Section:

1. Section 11 40 00 – Food Service Equipment – Kitchen Hoods and Wet Chemical Fire Suppression.
2. Section 28 31 00 – Digital Addressable Fire Alarm Systems.

1.3 CODES AND STANDARDS

A. Comply with the requirements of the most current version of the following, as applicable:

1. NFPA 13: Standard for installation of Sprinkler Systems.
2. NFPA 14: Standard for installation of Standpipes.
3. NFPA 24: Private Fire Service Mains.
4. Washington Administrative Code (WAC).
5. International Building Code (IBC).
6. International Fire Code (IFC).
7. Uniform Plumbing Code (UPC).
8. International Mechanical Code (IMC).

1.4 SCOPE

A. The meaning and intention of these specifications, in conjunction with the drawings, is to cover a completely installed, fully operating fire protection system for entire buildings. To accomplish this purpose, the Contractor shall provide all design, materials, equipment, labor necessary and required, and bear all expenses incidental to the satisfactory completion of the work. The suggested fire protection arrangement and information shown on the drawings are to indicate overall scope and general coverage and zoning but are not intended to be definitive or prescriptive. The fire protection contractor shall make all adjustments as required to provide a complete and fully functional fire protection system in accordance with all governing codes and standards.

B. It shall be the Contractor's responsibility to completely review all the disciplines of the construction bid set, to determine occupancy and hazard classifications, mezzanine locations, attics, false ceilings, concealed combustible spaces, skylights, crawl spaces, heated spaces, unheated spaces, overhangs, extended overhangs and patios, and any special hazards such as tire storage rooms, etc. and include all provisions required within the scope of the fire protection system being provided.

C. A dry pipe fire sprinkler system shall be provided when required to serve the areas indicated on the drawings.

D. It shall be the Contractor's responsibility to design and install the system so that no interferences exist between the fire protection piping, and equipment and systems designed and installed by others. The latest issues of all architectural, structural, mechanical and electrical drawings are available to assist the Contractor in preparing the design so as to avoid interferences.

E. The Contractor shall become familiar with all details of the work, verify all dimensions, and shall advise the Engineer of any discrepancies before submitting his bid.

F. Comply with all applicable local codes, state and local Fire Marshal's standards, International Building Code, International Fire Code, and NFPA 13 for installation of systems.

G. The design shall be governed first and foremost by code compliance and secondly by the specifications and contract documents. If a discrepancy exists between code and contract documents, the stricter shall be complied with. If such discrepancy exists, notification is expected prior to bidding and an addendum will be issued.
H. Coordinate installation of new fire protection system with the project phasing requirements and alternate bid areas so that the system is fully operational as each new/remodeled are occupied.

1.5 DESIGN CRITERIA
A. The Contractor shall develop full sets of shop drawings and final hydraulic calculations. These drawings shall show heads and piping coordinated with the final reflected ceiling plan and ductwork.
B. The design shall be in accordance with IFC, IBC, NFPA 13 and the local Authority Having Jurisdiction.
C. The fire protection Contractor shall include any applicable domestic and irrigation demands in the hydraulic calculations.
D. The water supply used for calculations is 55 psi static, and 50 psi residual with 1,050 flowing at the connection of the fire supply main at the city water main. A margin of 10% between all demand points and the water supply is required.
E. Desing Densities shall be in accordance in accordance with NFPA 13 and as follows.
1. Mechanical and Electrical rooms, storage rooms, science and chemistry rooms, kitchens and spaces shall be designed for ordinary hazard group 1 density.
2. Fab/Metal Shops, Welding Shops and similar spaces shall be designed for ordinary hazard group 2 density.
3. All other areas shall be designed in accordance with NFPA 13.

1.6 SUBMITTALS
A. Product Data: Furnish a complete list of fire protection equipment and products, and manufacturers catalog data sheets and maintenance data sheets for each item to be included in the project.
B. Shop Drawings: Submit drawings identified as “Working Drawings”, which have been prepared in accordance with NFPA 13, including hydraulic calculations, and which have been approved by the authority having jurisdiction. See Section 220000 for coordination requirements with other trades. Submittal drawings to contain locations of lights, ductwork, diffusers, etc. along with pipe routing and sprinkler heads. Any light fixtures which hang below the ceiling surface shall be noted with the depth that they extend below the ceiling surface. Submit evidence of final drawing approval by the authority having jurisdiction prior to the start of fabrication or installation.
C. Test Reports: Contractor shall perform hydrostatic testing of all system piping in accordance with NFPA Pamphlet 13. Provide complete Contractor Material and Test Certificates for each system/portion of system tested.

1.7 QUALITY ASSURANCE
A. Installer Qualifications: Installation of entire system shall be accomplished by a manufacturer of approved sprinkler equipment, his representative or licensee, who is now and has been engaged in the installation of automatic sprinkler systems for the past seven years.
B. Hydraulic calculations and sprinkler system design shall be done under direct supervision of Licensed FPE or a NICET level 3 sprinkler designer with experience in this profession.

1.8 DELIVERY AND STORAGE
A. All equipment placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust or other contaminants.

1.9 WARRANTEE OF MATERIAL AND WORKMANSHIP
A. Guarantee all work included in this section for a period of one year after date of Certificate of Substantial Completion. During that period, all defects due to faulty materials or workmanship and damage to other work, resulting thereof or the correction of same, shall be remedied at the

Contractor's expense. The guarantee shall be submitted in the form called for in the "Project Close-out."

PART 2 - PRODUCTS

2.1 PIPING

A. U.S. Manufacture: Allied, Wheatland, Sawhill, Textube, USX, Frontier, Maruichi American, Cyclops, LaCleadt.

B. Piping: Black or Galvanized steel, Schedule 40 or Schedule 10, ASTM A-53-78 or ASTM A-135-73A, Type E, Grade A or Grade B.

2.2 FITTINGS

A. Schedule 40, Black or Galvanized Steel, Pipe: Screwed joints, ANSI B2.1, mechanical grooved couplings joined by an UL and FM approved combination of bolted couplings, gaskets and grooves. Grooves may be rolled or cut and be dimensionally compatible with the coupling.

B. Schedule 10, Black or Galvanized Steel: UL and FM approved mechanical couplings. Couplings may be of the bolted rolled grooved type or the mechanical locking type. Grooves for the rolled grooved type shall be rolled only.

C. Cast Iron Screwed: ANSI B16.4.

D. Cast Iron Flanged: ANSI B16.1, or AWWA C 207.

E. Saddle type mechanical tees shall be acceptable for concealed pipe only.

F. Plain-end fittings/joints shall not be acceptable.

G. Mechanical pipe coupling housings shall be of malleable iron conforming to ASTM A 47, Grade 32510 or ductile iron conforming to ASTM A 536, Grade 65-45-12. Coupling nuts and bolts shall be of steel and conform to ASTM A 183.

H. Flange Gaskets: Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16-inch thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR).

I. Square head Bolts and Heavy Hexagon Nuts: ASME B18.2.1 and ASME B18.2.2, and ASTM A 307, ASTM A 575, or ASTM A 576.

2.3 ABOVE GRADE WALL/FLOOR PENETRATIONS

A. Pipe passing through rated walls shall be filled to the manufacturer's recommended thickness with fire resistant caulk.

B. Manufacturer: 3M Bio-Fire, FIPRO Firestop Systems A/D Fire barrier, or listed equal.

C. Escutcheons shall be chromium plated iron or chromium plated brass, either one piece or split pattern, held in place by internal spring tension or set screw.

2.4 BELOW GRADE WALL/FLOOR PENETRATIONS

A. Provide a positive hydrostatic sealing device rated at a minimum of 20 PSIG differential.

B. Device shall be removable from the sleeve without damage to device.

C. Manufacturers: Link Seal, or equal.

2.5 PIPING, HANGERS, INSERTS AND SUPPORT

A. Ferrule loop concrete inserts shall be Burke with no exception. Minimum edge distance shall be equal to twice the anchor length. Bolts must be inserted to a minimum depth equal to the bolt diameter.

B. Hangers shall be in accordance with NFPA 13 and in accordance with UL-04 requirements for use in sprinkler systems. When used, MSS SP-69 Type 19 and Type 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices furnished by the manufacturer. The C-clamp body shall not be constructed from bent plates.

C. Manufacturers: Elden, Fee and Mason, Grinnell, Tolco, or listed and approved equal.

D. Floor Supports: Supports shall be fabricated from structural members or shall be masonry piers. If steel pipe is used, the minimum size shall be 2" Schedule 40.

E. For this Contractor's information only, concrete inserts to be used in public areas with exposed structure shall be Burke "Straight Coil Loop Inserts". These inserts shall be supplied and installed by others. The sprinkler Contractor shall set the location for each insert.

2.6 INTERIOR CONTROL VALVES

A. Selection based on United Brass Works, Central, Grinnell, Kennedy, Victaulic, or listed and approved equal. All valves must be submitted and meet ratings as described below:

B. Sprinkler Control Valves: UL listed outside screw and yoke valves or butterfly valves may be used for floor control valves.

C. Dry pipe fire sprinkler Valve: UL Listed for use with dry pipe sprinkler system.

D. Resilient Seat Gate Valves: 2-1/2" inch and 3 inch size valves shall conform to the requirements of ASTM B62, MSS SP-80 or MSS SP-70 and UL-04; above 3 inch size, valves shall meet the requirements of MSS SP-70 or AWWA C500, and UL-04.

E. OS&Y Gate Valves (2-1/2" and larger): Iron Body, bronze trimmed, 200 psi WOG, with Henry pattern trim hand wheel. In addition to "1." above, valves shall be FM approved.

F. The cast iron hand wheel, yoke sleeve nut, yoke, bonnet, body, and disc shall conform to ASTM A-126-B. The ductile iron hand wheel nut and gland flange shall conform to ASTM A536. Steel nuts and bolts shall conform to ASTM A-307-B. The cast bronze yoke sleeve, disc nut and gland shall conform to ASTM B-62. The brass stem shall conform to ASTM B-16.
   1. Manufacturer: United Brass Works, Inc., Model 12, Kennedy, Model 68, or listed and approved equal.

G. OS&Y Gate Valves (1" to 2"): Bronze body con-forming to ASTM B62, 175 WOG (fire service), with cast iron hand wheel. In addition to "1." above, valves shall be FM approved.
   1. Manufacturer: United Brass Works, Inc., Model 18, Kennedy, Model 66, or listed and approved equal.

H. Slow Close Butterfly Valves: UL-04, grooved or wafer, with EPDM rubber molded disc and PPS body. Maximum working pressure shall be a minimum of 175 psi.
   1. Manufacturer: Victaulic Series 727 "Fireball" or listed equal.

2.7 INTERIOR AUXILIARY/UTILITY VALVES

A. Selection based on United Brass Works, Grinnell, Kennedy, Victaulic, or listed and approved equal. All valves must be submitted and meet ratings as described below.

B. Combination Inspection Test & Drain Valves:
   1. UL-04 and FM, bronze body, with chrome plated bronze ball, brass stem, steel handle, Teflon seat and site glass. Provide valve with three position indicator plate (off, test and drain), 1/4-inch tapping for pressure gauge and various sized orifice inserts to simulate flow through sprinkler heads.
   2. Manufacturer: Victaulic or listed and approved equal.

C. Globe and Angle Valves:
   1. UL-04, bronze body, replaceable non-metallic disc, slip-on disc holder, screwed ends, union bonnet, ventilated aluminum hand wheel and 300 lbs. WOG.
   2. Manufacturer: United Brass Works, Inc., Models 45S and 46S, Central, Models F15 and F16, or listed equal.

D. Ball Valves:
   1. The brass nut, stem gland screw, stem, and ball disc shall conform to ASTM B-16-C36000. The handle shall be steel conforming to ASTM A-283-D. The forged brass body and end plug shall conform to ASTM B-124-C37700. The Teflon stem packing thrust packing and ball disc packing shall be commercial grade PTFE.
   2. Manufacturer: United Brass Works or listed equal.

E. Gauge Isolation Valves:
   1. Bronze body with screwed bonnet and screwed 1/8" or 1/4" ends and 400 lbs. WOG.
   2. Manufacturer: United Brass Works, Inc., Model 76 or equal.

2.8 SWING CHECK VALVE

A. Under 3-inch size valves shall meet the requirements of MSS SP-80. All valves shall be UL-04 listed.

B. Valves 2-1/2 inch and greater:
   1. Shall be iron body, bronze mounted.
   2. All valves shall be listed in UL-04 or FM-P7825 Approval Guide and shall be straightway type, suitable for vertical or horizontal installation with end connections as required to mate with piping in which the valve must be installed.
   3. Manufacturer: Shotgun-90 (for riser applications), Grinnell, Victaulic, Viking or listed equal.

C. Valves 2 inches and smaller:
   1. The valve shall incorporate a bronze body, bronze cap and brass rod disc holder conforming to ASTM B-62. Brass rod hinge pin, brass rod hinge pin plug, brass plate disc washer and brass rod disc nut shall conform to ASTM B-16. The seat disc shall be commercial grade NBR.
   2. Manufacturer: Shotgun 90 (riser applications), United Brass Works, or listed equal.

2.9 FIRE DEPARTMENT CONNECTONS

A. Exposed, wall mount type, Polished chrome plated.

2.10 AUTOMATIC BALL DRIPS

A. UL-04, 3/4" cast brass inline automatic ball drip with both ends threaded with iron pipe threads. Pipe drain to spill through building wall over floor drain over mop sink or as approved.

B. Manufacturer: United Brass Works, Inc., Model 235 or equal.

2.11 GAUGES

A. Liquid filled sprinkler gauge, 3-1/2" dial, fitted with gauge valve shut-off in accordance with UL-04.

B. Manufacturer: Trerice, Marshall, or listed equal.

2.12 SPRINKLER ALARMING EQUIPMENT

A. Supervisory Valve Tamper Switch: UL-04 listed for supervisory control on all sprinkler system water supply control valves.
   1. The unit's base shall be formed steel. The cover shall be die-cast aluminum with corrosion resistant, red spatter enamel finish.
   2. The unit shall be weatherproof.
   3. The cover shall be held in place with two tamper resistant screws requiring a special key for removal.
   4. The unit shall contain two single pole double throw (SPDT), snap action switches.
   5. Manufacturers: Potter PCVS or PIVSU-A, Notifier, Grinnell.

B. Vane Type Water Flow Switch with Adjustable Retard: UL-04 listed water flow switches complete with adjustable delay.
   1. The unit shall be enclosed in a cast aluminum housing. The cover shall be held in place with two tamper resistant screws requiring a special key for removal.
   2. The unit shall contain two single pole double throw (SPDT), snap action switches and an adjustable pneumatic retard.
   3. The switches shall actuate when a flow of 10 gpm or more occurs downstream of the device.
   4. Adjustable retard settings shall be from 0 to 90 seconds.
   5. Manufacturers: Potter VSR-F and VSR-SF, Notifier, Grinnell.

2.13 SPRINKLER HEADS AND ASSOCIATED EQUIPMENT

A. Standard Response Upright (Standard Coverage, Light, Ordinary or Extra Hazard): 165 degrees F, 212 degrees F, 280 degrees F rated, fusible link. K=5.6, ½" NPT in brass finish. Manufacturer: Star TY-3111, Grinnell or Reliable.

B. Standard Response Pendant (Standard Coverage, Light, Ordinary or Extra Hazard): 165 degrees F, 212 degrees F, 280 degrees F rated, fusible link. K=5.6, ½" NPT in brass finish. Manufacturer: Star TY-3211, Grinnell or Reliable.

C. Standard Response Recessed (Standard Coverage, Light, Ordinary Hazard): 165 degrees F, 212 degrees F rated, fusible link. K=5.6, ½" NPT in chrome finish. Style 20 recessed escutcheon. Manufacturer: Star TY-3211, Grinnell or Reliable.
D. Standard Response Sidewall (Standard Coverage, Light, Ordinary or Extra Hazard): 165 degrees F, 212 degrees F, 280 degrees F rated, fusible link. K=5.6, ½" NPT in chrome finish. Manufacturer: Star TY-3311, Grinnell or Reliable.
E. Quick Response Upright (Standard Coverage, Light, Ordinary Hazard): 165 degrees F, 212 degrees F rated, fusible link. K=5.6, ½" NPT in brass finish. Manufacturer: Star TY-3121, Grinnell or Reliable.
F. Quick Response Pendant (Standard Coverage, Light, Ordinary Hazard): 165 degrees F, 212 degrees F rated, fusible link. K=5.6, ½" NPT in brass finish. Manufacturer: Star TY-3221, Grinnell or Reliable.
G. Quick Response Recessed (Standard Coverage, Light, Ordinary Hazard): 165 degrees F, 212 degrees F rated, fusible link. K=5.6, ½" NPT in chrome finish. Style 20 recessed escutcheon. Manufacturer: Star TY-3221, Grinnell or Reliable.
H. Quick Response Sidewall (Standard Coverage, Light, Ordinary Hazard): 165 degrees F, 212 degrees F rated, fusible link. K=5.6, ½" NPT in chrome finish. Manufacturer: Star TY-3321, Grinnell or Reliable.
I. Standard & Quick Response Pendant (Extended Coverage, Light Hazard): 165 degrees F rated, frangible bulb. K=8.0, ½" NPT in chrome finish. Manufacturer: Gem F890, Grinnell or Reliable.
J. Standard & Quick Response Recessed (Extended Coverage, Light Hazard): 165 degrees F rated, frangible bulb. K=8.0, ½" NPT in chrome finish. Model F705 recessed escutcheon. Manufacturer: Gem F890, Grinnell or Reliable.
K. Standard & Quick Response Horizontal (Extended Coverage, Light Hazard): 165 degrees F rated, frangible bulb. K=5.6, ½" NPT in chrome finish. Manufacturer: Star TY3322, Grinnell or Reliable.
L. Dry Horizontal Sidewall Sprinkler: 165 degrees F rated, fusible link, 1/2" orifice, K=5.6, 1" NPT in chrome finish. Manufacturer: Star series DS-1, Grinnell or Reliable.
M. Head Guards: Head guards shall be snap on type which fit snug and tight to head and shall fit upright sidewall or pendent models. Color shall be red. Manufacturer: Same as sprinkler head manufacturer with no exceptions.
N. Sprinkler Head Cabinet: Complete with sprinklers and special wrenches in accordance with NFPA 13. Manufacturer: Same as sprinkler head manufacturer

2.14 MISCELLANEOUS EQUIPMENT

A. Access Panels:
1. Access panels shall be suited for installation in dry wall, masonry, tile, wood, or other wall surfaces.
2. The door shall have rounded safety corners.
3. The door and frame shall be fabricated from 16 gage, galvanized steel and shall have a factory prime coat finish suitable for painting.
4. The frame shall be one piece construction, 1" wide and shall provide concealment of the rough wall opening. The frame shall have no miters or welds on the face. The wall frame shall be provided with 1/4" mounting holes for fastening within the furred space.
5. Doors less than 24" shall be provided with a concealed pivoting rod hinge. Doors 24" or larger shall be provided with a continuous piano hinge.
6. The latch shall be screwdriver operated.
7. Manufacturer: ELMDOR Manufacturing Co. or approved equal.

B. Valve Identification Signs:
1. Signs shall be constructed of metal. Lettering to be white on a red background.
2. Hydraulic Information Signs: Provide punched metal signs.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine work surfaces and substrates to receive work of this Section and report any defects which may affect work of this Section.
B. Confirm compatibility of surfaces to receive materials as specified within this Section.
C. Beginning of installation means acceptance of existing surfaces and substrates.

3.2 GENERAL INSTALLATION

A. Pipe shall be fabricated at risk of Contractor if not all approvals have been obtained.
B. Welding for flame cutting shall not be performed on or within the building without prior written approval of the Owners Representative.
C. The Contractor shall meet all requirements for interruption of existing services, and for Fire Department stand-by. This work shall be coordinated with the Architect and/or Owner.
D. Unless otherwise indicated or specified, all materials and equipment shall be installed in accordance with the manufacturer's recommendations and in accordance with NFPA 13.
E. Cutting structural members for passage of pipes or for pipe hanger fastenings will not be permitted unless the Contractor has been granted prior approval by the Architect and Engineer.
F. Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts, shall be so located as to be fully enclosed or guarded to prevent a person coming in contact therewith.

3.3 DRY PIPE SPRINKLER SYSTEM

A. Provide dry pipe fire sprinkler system using dry pipe valve. System shall conform to requirements of NFPA 13 and shall contain an air compressor; pressure switches for low air supervisory and alarm, check valve, pressure operated relief valve, manual release and emergency release. Provide all incidentals for a completely installed system.

3.4 PIPING

A. Piping shall be installed as indicated and specified. Pipe shall be cut accurately to measurement established at the building by the Contractor and shall be worked into place without springing or forcing and out of the way of all doors, windows and other openings. Pipes shall be installed so that it may expand and contract freely without damage to any other work or to itself. Piping in finished portion of the building shall be installed in such a manner as to require a minimum of furring. Pipe openings shall be closed with caps and/or plugged after installation to prevent entrance of foreign materials before final connection. The contract documents do not attempt to show all details of the piping. No extra payments will be allowed when obstructions in the work of others or work under this contract requires offsets in piping.
B. All pipe sizes shall be determined by hydraulic calculation(s) except for underground piping which is by others. Should local ordinances or codes be construed as requiring larger sizes in any instance, this shall be taken care of by the Contractor without additional cost to the Owner and shall be called to the attention of the Architect or Owner’s Representative.
C. All piping shall be arranged to provide the maximum amount of access so as to provide for future maintenance.

3.5 JOINTS

A. Joints shall conform to NFPA 13. Shop welded joints will be permitted. Flanged joints or mechanical grooved couplings shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Mechanical couplings and fittings shall be from the same manufacturer.
B. Threaded joints shall be cut with approved thread-cutting oil. Joints shall be made tight with a stiff mixture of litharge and glycerin or other approved thread joint compound or tape. Not more than three threads shall show after the joint is made up.
C. Flanged joints shall be faced true, provided with gaskets and made square and tight.

D. Mechanical grooved pipe joints shall conform to AWWA C606. Joints shall be made using a UL-04 listed or FM-P7825 approved combination of fittings, gaskets, and grooves. Cut or rolled pipe grooves shall be dimensionally compatible with the fittings.
E. Mechanical pipe couplings shall be of the bolted type and shall consist of a housing fabricated in one or more parts, a synthetic rubber gasket, and nuts and bolts to secure the unit together.
F. Gaskets shall be of molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000.

3.6 REDUCERS

A. Reductions in pipe sizes shall be made with one piece reducing fittings. Bushings will not be acceptable, except that when standard fittings of the proper size are not available, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in ore than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2 inch.

3.7 FLEXIBLE COUPLINGS

A. Provide listed and approved flexible couplings on sprinkler mains per NFPA regulations. Install UL approved hangers and earthquake bracing in place of supporting sprinkler piping.

3.8 PIPE SLEEVES

A. Pipes passing through concrete or masonry walls or concrete floors shall be provided with pipe sleeves fitted into place at the time of construction. Each sleeve shall extend through its respective all or floor and be cut flush with each surface. Unless otherwise indicated, sleeves shall be of such size as to provide a minimum of 1/4 inch all around clearance between the pipe and sleeve. Sleeves in bearing walls and wet areas shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls, floors, or ceilings may be steel pipe, cast iron pipe, or galvanized sheet metal with lock-type longitudinal seam.
B. Where pipes pass through fire walls, fire partitions, or floors, a fire seal of fire-resistant caulk shall be placed between the pipe and sleeve.

3.9 WALL/FLOOR/CEILING ESCUTCHEONS

A. Escutcheons shall be provided at all finished surfaces where exposed piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

3.10 PIPING, HANGERS, INSERTS AND SUPPORT

A. General: Provide hangers, brackets, supports, anchors, and related appurtenances, as required, to support all piping and equipment provided under this section. Piping and equipment supports shall conform to NFPA Pamphlet No. 13. Supports to be UL listed for pipe size being suspended.
B. Floor Supports: Provide where required, necessary floor supports for piping and equipment. Supports shall be fabricated from structural members or shall be masonry piers.
C. Hanging of pipes from ductwork is strictly prohibited.
D. Concrete inserts shall be set by others based on information provided by the sprinkler Contractor. This information will include both the location and size of the insert. The fire protection Contractor shall provide the ferrule loop inserts.

3.11 PIPING MAINTENANCE AND PROTECTION REQUIREMENTS

A. Flushing:
    1. Flushing arrangements shall be provided per NFPA 13 in accessible locations. Locations shall be approved by the Engineer.
    2. Flushing Connections: 1-1/4" nipples with caps at extreme ends of all cross mains.
    3. Disinfection/Chlorination: Not required.

3.12 DRAINS AND DRIPS

A. All piping shall drain back to the main riser. Where not possible, provide auxiliary drains discharging to architectural approved locations.

B. Install auxiliary drains at all low points in system. Five or fewer trapped heads will not require drain valve, but may be drained through plugged tee. Drain valves to be piped to safe place of discharge. Verify location of drains with Architect. Any drain not directly discharging to a receptacle must have a 3/4" hose line connection.

3.13 TESTS AND APPROVALS OF SPRINKLER SYSTEM

A. Hydrostatic Test: Test pipe of sprinkler systems with not less than 200 PSIG pressure for 2 hours in presence of Architect, Engineer, Owner, or authorized representatives of Fire Department. Provide approval certificates. Give ample advance notice of times at which tests are to be carried out, and, if work does not satisfactorily pass these, make all necessary corrections and repeat tests. Provide equipment, material, and labor necessary for inspection and tests. Carry out all tests prior to furring in or otherwise concealing pipe. No exceptions will be made. Preliminary tests may be done with compressed air.

3.14 SPRINKLER HEAD LOCATIONS AND SYSTEM ARRANGEMENT

A. Provide full sprinkler coverage of the area, including additional heads necessary to provide an adequate pattern of water discharge adjacent to partitions and around and beneath duct(s), doors, or other obstructions. Provide automatic sprinkler protection below ductwork 4'-0" or greater in width in accordance with NFPA 13.

B. Exact location of heads shall be carefully coordinated with other ceiling elements for a symmetrical pattern. Sprinkler heads shall not be located closer than 1' from lighting fixtures, diffusers, speakers or similar devices or obstructions. Contractor shall obtain coordination among the trades to avoid any interference with the potential effectiveness.

C. Provide flush recessed heads in all locker rooms, offices, restrooms corridors, commons and similar type locations within the building.

D. Provide head guards on all sprinkler heads located within multipurpose spaces.

E. Provide head guards for all sprinklers located with 6'-8" of walking surfaces.

F. Locate head boxes on the wall adjacent to system sprinkler risers.

3.15 SPARE SPRINKLERS

A. The Contractor shall furnish spare automatic sprinklers in accordance with the requirements of NFPA 13 for stock of extra sprinklers. The sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. The Contractor shall furnish no less than two special sprinkler head wrenches, or at least one head wrench for each sprinkler head box, whichever is greater.

B. Spare sprinklers and head wrenches shall be in head boxes. Locate boxes as specified above.

3.16 ACCESS PANELS

A. Any sprinkler valving or equipment which is in inaccessible areas shall be provided with an access panel by this Contractor. The panel shall be large enough to readily pass all equipment/manpower through to make repairs. The panel location is subject to approval by the Architect. Panel shall be rated the same as wall or ceiling in which it is located. Provide 6" x 6" red lettered place card made of metal. Attach to ceiling tile below the concealed device.

3.17 PAINTING

A. Painting of piping shall be by others in accordance with Section 09 91 00. The fire protection Contractor shall closely coordinate with the General Contractor to ensure that sprinkler heads are not painted. In the event sprinkler heads are painted, they shall be replaced with no additional cost to the Owner.

3.18 IDENTIFICATION

A. Piping Identification: Provide adhesive stickers every 40 feet on all cross-mains, bulk mains and pipes sized 2" or greater. Sticker to read "Fire Sprinkler."

B. Valve Identification: Signs: Provide identification sign (enamel on metal) to all valves in accordance with NFPA 13. Signs shall indicate purpose of valve and zone number or name.
C. Hydraulic Information Signs: Provide in accordance with NFPA 13. Locate on sprinkler riser. Sign shall indicate the system number/ name, design density, design area, hose stream demand and overall system demand.
D. Access Panel Signs: Provide access panel signs where access panels are used to conceal sprinkler system valving. Signs to be as specified above for “Valve Identification” but shall be pop-riveted to the access panel.

3.19 COMMISSIONING

A. The equipment and systems referenced in this section are to be commissioned per Section 018 – Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 21 10 00

DIVISION 22 – PLUMBING

SECTION 22 00 00 - GENERAL PLUMBING PROVISIONS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. Refer to BIDDING REQUIRMENTS, CONDITIONS OF THE CONTRACT, SUPPLEMENTARY CONDITIONS and DIVISION 01 of these specifications, which govern work under DIVISION 22. Refer to other sections of these specifications for additional related requirements.

1.2 SCOPE OF REQUIREMENTS

A. The work covered by Division 22 of the specifications shall include but not be limited to:
   1. Furnishing all materials and supplying all labor, equipment and services to install the complete plumbing system as shown on the accompanied drawings and specified herein.
   2. Compliance with the requirements of Section 230800, Mechanical Systems Commissioning.

1.3 DESCRIPTION OF WORK

A. The contract documents including specifications and construction drawings are intended to provide all material and labor to install complete plumbing systems for the new and existing portions of the building.

B. Every effort has been made on the design to meet or exceed the minimum requirements of the Codes; therefore, unless Contractor before signing his Contract, shall have notified the Architect, in writing, of any items in conflict with said Codes, he shall thereafter make any minor adjustments necessary to meet said Codes at no cost to the Owner.

C. The Contractor shall refer to the architectural interior detail, floor plans, elevations, and the structural and other Contract Drawings and he shall coordinate his work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and pipe lines and are not to be scaled; all dimensions shall be checked at the building.

D. The Contractor shall comply with the project close-out requirements as detailed in General Requirements of Division 01.

1.4 DESCRIPTION OF BID DOCUMENTS

A. Specifications:
   1. Specifications, in general, describe quality and character of materials and equipment.
   2. Specifications are of simplified form and include incomplete sentences.

B. Drawings:
   1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.
   2. Scaled and figured dimensions are approximate and are for estimating purposes only.
   3. Before proceeding with work check and verify all dimensions.
   4. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
   5. Make adjustments that may be necessary or requested in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
   6. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect or Engineer for his interpretation and decision as early as possible.

1.5 CODES PERMITS AND FEES

A. Plumbing work shall be in accordance with the following:

1. The latest edition of the International Building Code, International Mechanical Code, Uniform Plumbing Code, International Fire Code, National Electric Code, American Disability Act and all applicable State and Local Codes and Ordinances.
2. The Contractor at his expense shall obtain permits and inspections required for the mechanical work on this project. Deliver all inspection certificates to the Owner's Representative prior to final acceptance of the work.
3. Contractor shall pay all costs levied by utility companies and/or governing agencies associated with water, sanitary and storm sewer connections and include these costs within his bid. This shall include but not be limited to tap fees, service mains, meter and vault charges.

1.6 DEFINITIONS

A. The terms "The Contractor", when used in Division 22 shall mean the Contractor for plumbing work.
B. The term "Owners Representative" as used in Division 22 generally refers to the Architect or his designated representative in accordance with the General Conditions.
C. The term "Provide" shall mean furnish and install.

1.7 PROJECT REQUIREMENTS

A. See Section 01 11 00, Summary of work for requirements for employee identification, use of the site, and material deliveries to the site.
B. See Section 01 35 00, Special Procedures for project restrictions.

1.8 SEQUENCE AND SCHEDULING

A. See Section 01 11 00, Summary of work for sequence and scheduling information.
B. All trades are required to properly man the project to keep pace with the general contractor's schedule.

1.9 SAFETY AND PROTECTION

A. Safety Measures: The Engineer has not been retained to provide design and construction services relating to the Contractor's safety precautions, or means, methods, techniques, sequences or procedures required for the Contractor to perform his work. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement applies continuously and is not limited to normal working hours. Provide all required safety measures and consult with the State or Federal safety inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist or whether compliance with State or Federal regulations exist.
B. Head protection: Where pipe hangers, equipment support angles, etc., are exposed in access ways for any maintenance, cover all such potentially injurious protrusions less than 7'-0" above the floor with padding; secure and permanently fasten, and finish to match adjacent finishes.

1.10 PLUMBING COST BREAKDOWN

A. The Contractor shall furnish the Owner's Representative an itemized breakdown of the mechanical construction cost within 30 days of notice to proceed.
B. The cost breakdown shall be as follows:
   1. Mobilization
   2. Demolition
   3. Plumbing Piping Material
   4. Plumbing Piping Labor
   5. Plumbing Fixture Material
   6. Plumbing Fixture Set & Finish
   7. Insulation
   8. Closeout

1.11 GUARANTEE

A. The Plumbing equipment and installation shall be guaranteed for a period of one (1) year from the date of acceptance unless and individual item or specification is otherwise noted as longer. The Contractor shall make-good at his own expense all defects in his work, and/or equipment furnished by him, which shall develop at any time during the one year guarantee period and shall stand any expense of cutting and patching and repairing made necessary by his corrections of unsatisfactory work or equipment operation.

PART 2 - PRODUCTS

2.1 PIPING COORDINATION

A. Prior to installation of the new Division 22 systems, the Contractor shall coordinate the proposed installation with the Architectural and Structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension and Tile systems), and provide reasonable maintenance access requirements.

B. Provide means of access to all valves, dampers, controllers, operable devices and other apparatus which may require adjustment or servicing.

C. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Owners Representative of any discrepancies between that indicated on the Drawings and that existing in the field prior to any installation. Contractor shall be responsible for all costs associated with the removal or relocation of installed systems that have been installed without prior notification of the Owners Representative.

2.2 SHOP DRAWINGS AND SUBMITTALS

A. Submit Shop Drawings and Product Data per the requirements of Section 013300 Submittal Procedures

B. See individual Division 22 specification sections for additional submittal requirements.

C. Submittals of Product Data shall be bound in a black 3-ring binder with the project name on the cover. Data within this binder shall be arranged as follows:

1. Provide index tabs for each specification section in the same order and using the same name as appears in the Specifications.
2. Data shall be black and white, on 8 ½" x 11" or 11" x 17", single, one-sided sheets suitable for copying. Diagrams and drawings larger than 11" x 17" shall be submitted in reproducible form (translucent bond paper).
3. Drawings and catalog data must be clean, neat copies. Fax material or other poor-quality copies will not be acceptable.

D. If material or equipment is not as specified or submittal is not complete, it will be rejected. Only completed submittal including all applicable specification sections will be reviewed.

E. Indicate manufacturer, trade name and model number. Include copies of applicable brochure or catalogue material. Indicate sizes, types, model numbers, ratings, capacities and options actually being proposed.

F. Include dimensional data for roughing in and installation, and technical data sufficient to confirm that equipment meets requirements of drawings and specifications.

G. Include wiring, piping and service connection data, motor sizes complete with voltage ratings and schedules.

H. Submit six (6) copies of each shop drawing. The Engineer will retain one stamped copy, one will be provided to the Architect, one will be provided to the owner, one will be provided to the commissioning agent, and two stamped copies will be returned to the Contractor. The Contractor shall be responsible for distribution of required number of reviewed copies to parties other than the Owner's Representative(s).

2.3 RECORD DRAWINGS

A. Refer to Division 01.

B. Keep on site, an extra set of drawings and specifications recording changes and deviations daily. Return these drawings to the Owner's Representative at the completion of the Project. These drawings shall not be used for any other purposes.

2.4 OPERATING AND MAINTENANCE MANUALS

A. Refer to Section 017800 Closeout Submittals.
B. See individual Division 22 specification sections for additional Operating and Maintenance Manual requirements.

2.5 OPERATION AND MAINTENANCE TRAINING/STARTUP

A. Instruct the Owners representative(s) in operation and maintenance of mechanical systems utilizing the Operation and Maintenance Manual.
B. Individuals present shall include Contractors, subcontractors and equipment factory representatives. These individuals shall assist in instruction and start-up.
C. Instruction period shall occur after final inspection when systems are properly working.
D. Prepare statement and check list to be included in the Operation and Maintenance Manual. This Statement shall read as follows:
E. "The Contractor, associated factory representatives and subcontractors, have started each system and the total system and have proved their normal operation to the Owner's representative and have instructed him in the operation and maintenance thereof."

Owner's Representative Contractor

2.6 EQUIPMENT AND MATERIALS – STANDARDS/CODES

A. Materials used under this Contract, unless specifically noted otherwise, shall be new and of the latest and most current model line produced by the manufacturer. Each item of equipment shall conform to the latest Standard Specifications of the American Society for Testing Materials and shall conform to any applicable standards of the United States Department of Commerce.
B. Instruct the Owners representative(s) in operation and maintenance of mechanical systems utilizing the Operation and Maintenance Manual. Motor and equipment name plates as well as applicable UL and AGA labels shall be in place when the Project is turned over to the Owner.
C. All electrically driven or connected equipment shall be provided with UL or equivalent label and/or listing in accordance with the requirements of the NEC.
D. All control panels shall be provided with UL or equivalent Label and/or listing in accordance with the requirements of the NEC an applicable local codes.

2.7 EQUIPMENT/MATERIAL SUBSTITUTIONS

A. Refer to Section 012500 Substitution Procedures for product prior approval and substitution requirements.
B. Throughout these specifications and drawings, various materials, equipment, apparatus, etc., are specified or scheduled by manufacturer, brand name, type or catalog number. Such designation is to establish standards of desired quality and construction and shall be the basis of design and the bid.
C. Submit proposals to supply alternative materials or equipment in writing, in accordance with Section 012500 Substitution Procedures.
D. Equipment manufacturers listed in individual sections are approved alternatives for this project and are subject to requirements of drawings and specifications. Revisions required to adapt alternatives shall be the responsibility of the Contractor.

E. Products furnished other than the (basis of design) shall have similar electrical characteristics as the scheduled or specified equipment. Contractor shall be responsible for any electrical changes caused by products not in accordance with this requirement.

2.8 EQUIPMENT PROTECTION AND CLEAN-UP

A. Protect equipment and materials in storage on site, during and after installation until final acceptance. Leave factory covers in place and take special precautions to prevent entry of foreign material into working parts of piping and duct systems.
B. Protect equipment with polyethylene covers and crates.
C. Operate, drain and flush bearings and refill with change of lubricant before final acceptance.
D. Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Provide extended nipples for lubrication.
E. Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not re-use existing materials and equipment unless specifically indicated.

PART 3 - EXECUTION

3.1 LOCATIONS

A. Coordination of Division 22 equipment and systems to the available space, with other trades. The access routes through the construction shall be the Contractor's responsibility.
B. Drawings are diagrammatic. Make offsets, transitions, and changes in direction of pipes, as required to maintain proper headroom and pitch of sloping lines and avoid structural, electrical, pipe and duct interference's whether or not indicated on Drawings. Furnish fittings, etc., as required to make these offsets, transitions and changes in direction at no additional cost to the Owner.
C. Determine exact route and location of each pipe and coordinate and obtain approval for changes from the layout indicated on the drawings with the Owner's Representative prior to fabrication.
D. Locations of equipment and devices, as shown on the drawings, are approximate unless dimensioned. Verify the physical dimensions of each item of plumbing equipment to fit the available space and promptly notify the Owner's Representative prior to roughing-in if conflicts appear.
E. All piping, equipment, tubing, etc., shall be concealed within building construction unless otherwise noted, or in mechanical rooms.
F. Arrange pipes, and equipment to permit ready access to valves, unions, traps, trap primers, and to clear openings of doors and access panels.

3.2 CUTTING AND PATCHING

A. All cutting and patching of new and existing construction required for the installation of systems and equipment specified in Division 22 shall be the responsibility of the Division 22 Contractor. It shall also be said contractors responsibility to determine location and amount of saw-cutting required. All cutting shall be accomplished with masonry saws, drills or similar equipment to provide neat uniform openings.
B. Patch and repair walls, floors, ceilings and roof with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials. All patching shall meet the approval of the Owner's Representative.
C. All cutting and patching made necessary to repair defective equipment, defective workmanship or be neglect of this Contractor to properly anticipate his requirements shall be included in Division 22.
D. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses or other structural members without the Owner Representative's written approval.

3.3 SCHEDULING

A. It is understood that while drawings are to be followed as closely as circumstances permit, the Contractor shall be responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Owner's Representative. Should conditions arise where certain changes would be advisable, secure approval from the Owner's Representative for those changes before proceeding with work.

B. Coordinate with the work of various trades when installing interrelated work. Before installation of mechanical items, make proper provision to avoid interference's. Changes required in work specified in Division 22 caused by neglect to do so shall be made at no cost to Owner.

C. Furnish and install inserts and supports required by Division 22 unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to those involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne under Division 22.

3.4 EXISTING UTILITIES AND PIPING

A. The locations of existing concealed lines and connection points have been indicated as closely as possible from available information. The Contractor shall assume that such connection points are within a Ten foot (10') radius of the indicated location. Where connection points are not within this radius, the Contractor shall contact the Owner's Representative for a decision before proceeding or may proceed at his own expense.

B. Connection points to existing work shall be located and verified prior to starting new work.

C. Prior to commencing any excavation or ditching activity, the Contractor shall verify the exact location and inverts of all existing utilities and connection points in the area of his proposed excavation. Notify Owner's representative for further direction if actual inverts will not allow the proper installation of new work.

D. The Contractor shall be responsible for damages, which might be caused by his failure to exactly locate and preserve underground utilities.

3.5 PHASING AND SEQUENCE OF WORK

A. All connections to and disconnections from existing utilities shall be coordinated with and approved by the Owner prior to proceeding with the work. Work shall be planned so as to minimize impact to areas not involved in ongoing construction. Where areas not involved in ongoing construction are to be impacted, the contractor shall identify such areas, the extent to which they will be affected and the period of time for which they will be affected. All new and relocated piping shall be installed, cleaned and tested prior to making connection to existing systems. Provide required temporary mechanical connections to accommodate the nature of this work.

B. The contractor is advised that the above notification and scheduling requirement may necessitate rescheduling, partial completion and reconnection, overtime work at night or on weekends or delay of the work. Contractor costs incurred due to the above shall be included in the original bid price and shall not be the cause for additional claims or charges to the Owner.

3.6 TESTS

A. Piping systems shall be subject to tests as specified below. No piping shall be covered or concealed until it has been tested, inspected and approved by the Owner's Representative and any local inspector having jurisdiction. Isolate systems during testing and flushing. Equipment items with maximum working pressure of less than the test pressure shall be removed or bypassed during test.

B. A record similar to the following shall be kept to record each test and copies shall be sent to the Owner's Representative after each test is complete.

C. OWNER'S REPRESENTATIVE OR LOCAL INSPECTOR:

SYSTEM TESTED	TESTED BY	INSPECTOR	DATE

Domestic Water Piping

Waste

Vent

Roof/Overflow Drain

D. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing that the specified tests have been performed and that the installation complies with the specified requirements.

E. Piping: Remove from the system during testing, all equipment which would be damaged by test pressure. Replace removed equipment when testing has been accomplished. The systems may be tested in sections as the work progresses; however, any previously tested portion shall become a part of any latter test of a composite system. Correct leaks by remaking joints with new material.

F. Test time will be accrued only while full test pressure in on the system, unless indicated otherwise. Tolerance shall be no pressure drop, except that due to temperature change in a 24-hour period. Inspect and test all work prior to burying or concealing.

System	Test Medium	Test Pressure	Tolerance-Test Period
Domestic Water	Water	120 psig	None – 4 Hours
Waste	/Vent	Water	10 feet head, 5 psi
			No Leaks – 5 Hours
Roof/Overflow Drain	Water	10 feet head, 5 psi	No Leaks – 5 Hours

3.7 SYSTEM CLEANING AND FLUSHING

A. The following piping systems shall be flushed, cleaned, disinfected, etc. by a recognized professional firm engaged in the business of pipe cleaning and water treatment. Work shall be accomplished in accordance with the following requirements. Work shall be fully documented by means of certificates stating work accomplished, methods used and date work was done. System cleaning and flushing shall be done by Inland Aqua Tech, King Total Systems, or approved equal.

1. Domestic Water (Inside Foundation Perimeter)
    a. Disinfect water mains and water service piping, in accordance with AWWA C 601. Domestic water lines shall be chlorinated by injecting chlorine at the entrance main (where new waterline connects to existing main outside the building) and maintaining 100 PPM concentration at every plumbing fixture for a 24-hour period. Flush until chlorine level is same as incoming water. Water samples shall be submitted and approved by the Local Co. health authority prior to acceptance and occupancy by the District. Approval by the District Representative is conditional on receipt of documentation. Note: water samples shall be taken at appropriate locations throughout the building to assure complete sampling of all domestic water systems.
    b. Domestic water heater shall be chlorinated in the same manner as the domestic water piping, and maintaining 100 PPM concentration for a 24-hour period. Flush until chlorine level is same as incoming water. Water samples shall be submitted and approved by the Local Co. health authority prior to acceptance and occupancy by the District. Approval by the District Representative is conditional on receipt of documentation.

3.8 PROJECT FINALIZATION & STARTUP

A. Upon completion of the equipment and systems installation and connections, the Contractor shall assemble all major equipment factory representatives and subcontractors together for system start-up and Owner instructional period.

B. These individuals shall assist in start-up and check out of their systems and shall remain at the site until the system operation is acceptable and understood to the Owner's maintenance and/or operation personnel.
C. To provide acceptance of operation and instruction by the Owner's representative, the Contractor shall prepare a written statement of acceptance explaining same for the Owner's signature.
D. The statement should read as follows:
E. "I, the Contractor, associated factory representative and subcontractor, have started each

system and the total system and have proved their normal operation to the Owner's

representative and have instructed him in the operation and maintenance thereof."

Owner's Representative Contractor

F. Copies of this acceptance shall be sent to the Engineer and the Architect, and one copy shall be placed in each maintenance manual.

3.9 PUNCH LIST PROCEDURES

A. The Contractor shall notify the Owner’s Representative in writing when the project is ready for punch lists. After punch lists are complete, written notice must be forwarded to the Owner’s Representative requesting final checkout.
B. At the time of final observation, the project foreman shall accompany the observation party and shall remove access panels as required, to allow complete observation of the entire plumbing system.

END OF SECTION 22 00 00

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Dielectric fittings.
   3. Sleeves.
   4. Escutcheons.
   5. Plumbing demolition.
   6. Equipment installation requirements common to equipment sections.
   7. Supports and anchorages.
   8. Access doors.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.
C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
E. Welding Filler Metals: Comply with AWS D10.12.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
B. Insulating Material: Suitable for system fluid, pressure, and temperature.
C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.4 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.5 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
C. One-Piece, Cast-Brass Type: With set screw.
    1. Finish: Polished chrome-plated.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping to permit valve servicing.
G. Install piping at indicated slopes.
H. Install piping free of sags and bends.
I. Install fittings for changes in direction and branch connections.
J. Install piping to allow application of insulation.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Install escutcheons for penetrations of walls, ceilings, and floors.
M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Section 079005 "Firestopping" for materials.
O. Verify final equipment locations for roughing-in.
P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

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

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

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

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

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

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

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

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

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 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. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
D. Install equipment to allow right of way for piping installed at required slope.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

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

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

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

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

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

3.7 ACCESS DOORS

A. Access doors to match surrounding surface, provided with recess to accept matching finish. Provide UL rated doors in fire rated construction.

B. Provide 12”x12” access doors for maintenance or adjustments purposes for all mechanical system components including valves, volume dampers, fire dampers, fire/smoke dampers, clean outs, traps and controls.

C. Refer to Section 08 31 00 "Access Doors and Panels”.

END OF SECTION 22 05 00

SECTION 22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 – GENERAL

1.1 SUMMARY
- A. Section Includes:
  1. Metal-bellows expansion joints.
  2. Pipe bends and loops.
  3. Alignment guides and anchors.

1.2 SUBMITTALS
- A. Product Data: For each type of product indicated.
  1. First paragraph below is defined in Division 01 Section "Submittal Procedures" as a "Delegated-Design Submittal." Retain if Work of this Section is required to withstand specific design loads and design responsibilities have been delegated to Contractor or if structural data are required as another way to verify compliance with performance requirements. Professional engineer qualifications are specified in Division 01 Section "Quality Requirements."
- B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
  2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
  3. Alignment Guide Details: Detail field assembly and attachment to building structure.
  4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
- C. Welding certificates.
- D. Product certificates.
- E. Maintenance data.

1.3 QUALITY ASSURANCE
- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  1. Retain "Welding Qualifications" Paragraph below if shop or field welding is required. If retaining, also retain "Welding certificates" Paragraph in "Submittals" Article.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
  1. Retain applicable subparagraphs below.
  2. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."
  3. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS
- A. Coordinate expansion-joint pressure and temperature ratings with piping systems.
- B. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.
  1. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of first two subparagraphs and list of manufacturers below. See Division 01 Section "Product Requirements."
  2. Manufacturers: Subject to compliance with requirements, provide product by one of the following:

a. Adsco Manufacturing, LLC.
b. Anamet, Inc.
c. Badger Industries.
d. Expansion Joint Systems, Inc.
e. Flex-Hose Co., Inc.
f. Flexicraft Industries.
g. Flex-Pression, Ltd.
h. Flex-Weld, Inc.
i. Hyspan Precision Products, Inc.
j. Metraflex, Inc.
k. Piping Technology & Products, Inc.
l. Proco Products, Inc.
m. Senior Flexonics, Inc.; Pathway Division.
n. Tozen America Corp.
o. Unaflex Inc.
p. WahlcoMetroflex.

3. Metal-Bellows Expansion Joints for Copper Piping: Single or multiple-ply phosphor-bronze bellows, copper pipe end connections, and brass shrouds.
4. Metal-Bellows Expansion Joints for Stainless-Steel Waterway: Single-ply stainless-steel bellows, stainless-steel-pipe end connections, and steel shroud.
5. Metal-Bellows Expansion Joints for Steel Piping: Single or multiple ply stainless-steel bellows, steel pipe end connections, and carbon-steel shroud.
6. Minimum Pressure Rating: 150 psig (1035 kPa), unless otherwise indicated.
7. Configuration: Single or double bellows type with base, unless otherwise indicated.
8. End Connections: Flanged or weld.

2.2 ALIGNMENT GUIDES

A. Indicate alignment-guide length and maximum spider travel on Drawings.

B. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

1. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of two subparagraphs and list of manufacturers below. See Division 01 Section "Product Requirements."
2. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
   a. Adsco Manufacturing, LLC.
   b. Advanced Thermal Systems, Inc.
   c. Flex-Hose Co., Inc.
   d. Flexicraft Industries.
   e. Flex-Weld, Inc.
   f. Hyspan Precision Products, Inc.
   g. Metraflex, Inc.
   h. Piping Technology & Products, Inc.
   i. Senior Flexonics, Inc.; Pathway Division.

2.3 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Stainless-steel studs are available.

2. Stud: Threaded, zinc-coated carbon steel.
3. Expansion Plug: Zinc-coated steel.
4. Washer and Nut: Zinc-coated steel.

E. Concrete: Portland cement mix, 3000 psi (20.7 MPa) minimum. Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

F. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, non-metallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 PIPE BEND AND LOOP INSTALLATION

A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
1. If retaining first paragraph below, show dimensions of loops and locations of guides and anchors on Drawings.

B. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

C. Attach pipe bends and loops to anchors.
1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.3 SWING CONNECTIONS

A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.4 ALIGNMENT-GUIDE INSTALLATION

A. Install guides on piping adjoining pipe expansion fittings and loops.
1. Coordinate paragraph below with structural Sections and Drawings if welding is included in structural work.
2. Show locations and quantity of guides on Drawings.

B. Install guides on piping adjoining pipe expansion fittings and loops.
1. Coordinate paragraph below with structural Sections and Drawings if welding is included in structural work.

C. Attach guides to pipe and secure to building structure.

3.5 ANCHOR INSTALLATION

A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

1. Coordinate first paragraph below with structural Sections and Drawings if welding is included in structural work.

B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION 22 05 16

SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY
- A. Section Includes:
  1. Thermometers.
  2. Gages.

1.2 SUBMITTALS
- A. Product Data: For each type of product indicated.

PART - 2 PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Palmer - Wahl Instruments Inc.
  2. Trerice, H. O. Co.
  3. Weiss Instruments, Inc.
  4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Case: Chrome-plated brass, 9 inches (178 mm) long.
- C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.
- D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- E. Window: Glass.
- F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.
- H. Accuracy: Plus, or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 BIMETALLIC-ACTUATED DIAL THERMOMETERS
- A. Manufacturers: Subject to compliance with requirements, by one of the following:
  1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
  2. Ernst Gage Co.
  3. Eugene Ernst Products Co.
  4. Marsh Bellofram.
  5. Miljoco Corp.
  6. NANMAC Corporation.
  7. Noshok, Inc.
  8. Palmer - Wahl Instruments Inc.
  9. REO TEMP Instrument Corporation.
  10. Tel-Tru Manufacturing Company.
  11. Trerice, H. O. Co.
  12. Weiss Instruments, Inc.
  13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
  14. WIKA Instrument Corporation.
  15. Winters Instruments.
- B. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.

C. Case: Liquid-filled type, stainless steel with 5-inch (127-mm) diameter.

D. Element: Bimetal coil.

E. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

F. Pointer: Red metal.

G. Window: Glass.

H. Ring: Stainless steel.

I. Connector: Adjustable angle type.

J. Stem: Metal, for thermowell installation and of length to suit installation.

K. Accuracy: Plus, or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 THERMOWELLS

A. Manufacturers: Same as manufacturer of thermometer being used.

B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.4 PRESSURE GAGES

A. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of first two paragraphs and list of manufacturers below. See Division 01 Section "Product Requirements."

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

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Eugene Ernst Products Co.
5. KOBOLD Instruments, Inc.
6. Marsh Bellofram.
7. Miljoco Corp.
8. Noshok, Inc.
9. Palmer - Wahl Instruments Inc.
10. REO TEMP Instrument Corporation.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

C. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Liquid-filled type, drawn steel or metal type, 6-inch (152-mm) diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4 (DN 8), bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red metal.
7. Window: Glass.
8. Ring: Stainless steel.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.

10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
11. Range for Fluids under Pressure: Two times operating pressure.
12. Pressure-Gage Fittings:
13. Valves: NPS 1/4 (DN 8) brass or stainless-steel needle type.
14. Snubbers: ASME B40.5, NPS 1/4 (DN 8) brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the outlet of each domestic, hot-water storage tank.
B. Install liquid-filled-case-type, bimetallic-actuated dial thermometers at suction and discharge of each pump.
C. Provide the following temperature ranges for thermometers:
   1. Other temperature ranges and units with both Fahrenheit and Celsius scales are available.
   2. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions (Minus 1 to plus 82 deg C, with 1-degree scale divisions)
   3. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions (Minus 18 to plus 38 deg C, with 1-degree scale divisions)

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.
B. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.
B. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.
C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
D. Install needle-valve and snubber fitting in piping for each pressure gage.
E. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.
F. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION 22 05 19

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

PART 1 - GENERAL

1.1 SUMMARY
- A. Section Includes:
  1. Bronze ball valves.
  2. Bronze butterfly valves.
  3. Check Valves
  4. Pressure Reducing Valves
  5. Hot Water Recirculation Valves
- B. Related Sections:
  1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
  2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.2 SUBMITTALS
- A. Product Data: For each type of valve indicated.

1.3 QUALITY ASSURANCE
- A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
- B. NSF Compliance: NSF 61 for valve materials for potable-water service.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES
- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
  1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
  2. Handwheel: For valves other than quarter-turn types.
  3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
- E. 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.
- F. Valve-End Connections:
  1. Flanged: With flanges according to ASME B16.1 for iron valves.
  2. Threaded: With threads according to ASME B1.20.1.

2.2 BRONZE BALL VALVES
- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
     a. Milwaukee BA Series
     b. Hammond of Equal Product to Milwaukee BA Series
     c. Apollo
  2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig WOG.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Bronze.
j. Port: Full.

2.3 BUTTERFLY VALVES

A. Class 150:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hammond Valve.
   b. Milwaukee C Series
   c. Meuller.
   d. Equal NIBCO to the above manufacturers
   e. Apollo.
2. Description:
   a. Standard: MSS SP-67.
   b. CWP Rating: 250 psig.
   c. Body Material: ASTM A 126 CL B, Cast Iron.
   d. Ends: Flanged.
   e. Stem: Stainless.
   f. Disc: Aluminum Bronze ASTM B 148.
   g. Liner: EPDM
   h. Seal: EPDM
   i. Operator: Lever Handle
   j. Full Lug Style

2.4 CHECK VALVES

A. Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hammond Valve.
   b. Milwaukee.
   c. Nibco.
   d. Watts.
   e. Apollo.
2. Description:
   a. Standard: MSS SP-80, ASTM B62 and ASTM B16 cast bronze body for 2” and smaller Screwed ends. Teflon Bronze Disc.
   b. Standard: MSS SP-71, ASTM A126 class B cast iron body for 2-1/2” and Larger. Flanged ends. Cast Iron Disc.

2.5 RELIEF VALVES

A. Relief Valve: Watts vacuum relief valve, bronze body, silicone disc, threaded ends, installed on cold water supply line only, refer to Hot Water Heater Detail on drawings.

B. Temperature and pressure Relief Valve: Watts, bronze body construction, thermostat and test lever, temperature relief set at 210 degrees F, and pressure relief set at 150 psig.

2.6 BACKFLOW PREVENTION VALVES

A. Reduced Pressure Zone Backflow Preventer for High Hazard Applications:

1. 2” and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1013 and AWWA C506. Bronze construction, threaded ends, stainless steel internal parts and air gap fitting. Route pipe from air gap fitting to approved waste receptor.
2. 2-1/2” and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet with strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C506. Epoxy coated cast iron body construction, flanged ends, stainless steel internal parts, bronze eats, and air gap fitting. Route pipe from air gap fitting to approved waste receptor.

B. Double Check Valve for Low Hazard Applications:
1. 2” and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C506. Bronze construction, threaded ends, and stainless-steel internal parts.
2. 2-1/2” and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet with strainer on inlet. Assemblies shall include test cocks and two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C506. Epoxy coated cast iron body construction, flanged ends, stainless steel internal parts.

C. Atmospheric Vacuum Breaker: Assembly shall consist of a bronze vacuum breaker body with silicone disc, and full-size orifice. Device shall be IAPMO listed, meet ASSE standard 1001, and ANSI standard A113.1.1. Chrome plated in finish areas.

D. Pressure Vacuum Breaker: Assembly shall consist of a one-piece bronze or stainless-steel body, with stainless steel spring loaded check, rubber diaphragm, and atmospheric vent, breakaway set screw. Chrome plated in finish areas.

2.7 PRESSURE REDUCING VALVES

A. Provide as indicated on the drawings.
1. Single seated, direct operated type; high capacity, having bronze body with strainer, by-pass feature, pressure gauge tapping and complying with the requirements of ASSE Standard 1003.

2.8 HOT WATER RECIRCULATION BALANCING VALVES

A. Pressure Independent Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flow Design Inc
   b. Hays
   c. Approved equal manufacturer to above.
2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
4. Combination Assemblies: Include bonze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 250 deg F.

B. Pressure Dependent, Bronze, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Flow Design Inc.

d. Hays.
e. Red-White
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
7. Pressure Gage 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.

C. Pressure Dependent, Cast-Iron or Steel, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong Pumps, Inc.
b. Bell & Gossett Domestic Pump; a division of ITT Industries.
c. Flow Design Inc.
d. Hays.
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage 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.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.2 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.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
1. Shutoff Service: Ball or butterfly valves.
2. Throttling Service: ball valves.
B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
C. Select valves, except wafer types, with the following end connections:
1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
2. For Copper Tubing, NPS 21/2 and Larger: Threaded or flanged ends.

3.4 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Ball Valves: Provide with threaded ends.

B. Pipe NPS 21/2 and Larger:
   1. Cast Iron Butterfly Valves: Provide with threaded or flanged ends.

END OF SECTION 22 05 23

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

PART - 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Equipment supports.

B. See Section 055000 Metal Fabrications for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.2 DEFINITIONS

A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Equipment supports.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
B. Manufacturers:
   1. B-Line Systems, Inc.; a division of Cooper Industries.
   2. ERICO/Michigan Hanger Co.
   3. Grinnell Corp.
   4. National Pipe Hanger Corporation.
   5. PHD Manufacturing, Inc.
   6. Piping Technology & Products, Inc.
C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

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

2.4 METAL FRAMING SYSTEMS
A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
B. Manufacturers:
   1. B-Line Systems, Inc.; a division of Cooper Industries.
   2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
   3. Power-Strut Div.; Tyco International, Ltd.
   4. Thomas & Betts Corporation.
   5. Unistrut Corp.; Tyco International Ltd.
C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS
A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.
B. Manufacturers:
   1. Carpenter & Paterson, Inc.
   2. ERICO/Michigan Hanger Co.
   3. PHS Industries, Inc.
   4. Pipe Shields, Inc.
   5. Rilco Manufacturing Company, Inc.
   6. Value Engineered Products, Inc.
C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
   a. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS
A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:
    a. B-Line Systems, Inc.; a division of Cooper Industries.
    b. Empire Industries, Inc.
    c. Hilti, Inc.
    d. ITW Ramset/Red Head.
    e. MKT Fastening, LLC.
    f. Powers Fasteners.

2.7 EQUIPMENT SUPPORTS

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

2.8 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Use padded hangers for piping that is subject to scratching.
F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
    b. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
    c. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
    d. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
    e. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
    f. 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.
    g. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
    h. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    a. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
    b. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

a. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
b. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
a. Light (MSS Type 31): 750 lb.
b. Medium (MSS Type 32): 1500 lb.
c. Heavy (MSS Type 33): 3000 lb.
8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

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

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

L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

3.2 HANGER AND SUPPORT INSTALLATION

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

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

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

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

E. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

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

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

H. 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.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.
   a. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping.

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

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

L. Insulated Piping: Comply with the following:
   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 according to ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   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 and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
      f. Pipes NPS 8 and Larger: Include wood inserts.
   5. Insert Material: Length at least as long as protective shield.
   6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

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

B. Provide lateral bracing, to prevent swaying, for equipment support.

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 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 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.

END OF SECTION 22 05 29

SECTION 22 05 50 - PLUMBING SEISMIC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

B. Contractor furnished design and installation for seismic restraints for plumbing piping and equipment.

1. Fuel gas piping.
2. Water Heaters.
3. For Fire Sprinkler System Seismic Restraints refer to Division 21.

C. Definitions & Referenced Standards:

1. Building Codes: IBC 2006, ASCE7, Applicable State and Local Codes
2. FEMA: Federal Emergency Management Agency
3. FEMA Seismic Restraint Installation Manuals 412 & 414
   a. FEMA 412: Installing Seismic Restraints for Mechanical Equipment
   b. FEMA 414: Installing Seismic Restraints for Duct and Pipe
4. S_1: Mapped Long Period Seismic Acceleration Coefficient IBC
5. Ss: Mapped Short Period Seismic Acceleration Coefficient IBC
6. VISCMA: The Vibration Isolation and Seismic Control Manufacturers Association has developed Testing and Rating Standards for Seismic Restraint Components that comply with Code and ASHRAE based requirements.
7. VISCMA 102-2007: Static Qualification Standards for Obtaining a VISCMA Compliant Seismic Component Rating.
8. ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.)
9. ASHRAE Applications Handbook: Seismic and Wind Restraint Design Chapter
10. ASHRAE SPC-171: Method of Test for Seismic Restraints

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Design Requirements: The contractor and the seismic restraint manufacturer shall provide seismic restraints and design as follows:

B. Seismic Design Category, SDC = A or B:

1. No seismic restraints required on mechanical or plumbing systems.

C. Seismic Design Category, SDC = C:

1. Mechanical Systems/Equipment Component Importance Factor, I_P = 1.0: No seismic restraint required.
2. Mechanical Systems/Equipment Component Importance Factor, I_P = 1.5: seismic restraints and design required.

D. Seismic Design Category, SDC = D (E or F):

1. Seismic restraints and design required for all mechanical and plumbing systems and equipment regardless of Component Importance Factor.

E. Exemptions: where seismic restraint and design is otherwise required, the following general exemptions shall apply (see detailed code language for specific criteria):

1. I_P = 1.0, wP ≤ 400 lbs, flexible connections, mounted 4 feet or less above floor: no seismic restraint required.
2. IP = 1.0, wP ≤ 20 lbs, flexible connections: no seismic restraint required.
3. IP = 1.0, piping or ductwork distribution ≤ 5 lbs/ft: no seismic restraint required.
4. 12" Rule: Ductwork or piping supported within 12" of the structure along the entire length of run (from top of pip or duct to structure).

F. Seismic-Restraint Design Criteria – Project Specific (see Structural Plans):
   1. Site Class as Defined in the IBC: Site Class = D
   2. Assigned Seismic Occupancy Category of Building as Defined in the IBC: III
   3. Design Spectral Response Acceleration at Short Periods (0.2 Second): SS = 0.389
   4. Design Spectral Response Acceleration at 1-Second Period: S1 = 0.122
   5. Spectral Design Response Coefficient (Short Period): SDS = 0.389g
   6. Spectral Design Response Coefficient (1-Second Period): SD1 = 0.176g
   7. Seismic Design Category, SDC = C.

G. Component Importance Factors (I_P):
   1. $I_P = 1.5$
      a. Natural gas & fuel oil piping.
      b. Laboratory exhaust systems or other hazardous fumes.
      c. Boilers, water heaters, furnaces & flue systems.
      d. Medical gas piping & equipment.
      e. Smoke removal & fresh air systems & equipment.
      f. Fire sprinkler piping & systems.
      g. Hospital HVAC systems.
      h. High pressure steam piping.
      i. All systems in Seismic Occupancy Category IV (Hospitals; fire, rescue, ambulance, police stations; emergency operation centers; etc.)
   2. $I_P = 1.0$
      a. All other mechanical and plumbing systems not specifically designated above as $I_P = 1.5$.

1.3 SUBMITTALS

A. Product Data: Include VISCMA Seismic Rating documentation for each seismically rated isolator or restraint component. Include ratings for horizontal, vertical and combined loads.

B. Shop Drawings shall include the following:
   1. Design Calculations: Calculate requirements for selecting seismic restraints. Certification documents to be signed and sealed by a qualified Professional Engineer with at least 5 years experience in the design of seismic restraints.
   2. Floor plans showing equipment, ductwork and piping with indication of required seismic restraint locations and types with cross-reference to applicable details and bill of material.
   3. Seismic-Restraint Details: Detailed submittal drawings of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration, edge distance and spacing of anchors.
   4. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   5. Detailed description of the specified equipment anchorage devices on which the certification is based.

1.4 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1, “Structural Welding Code—Steel” and WABO certification.

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency, such as VISCMA, acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to

support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.5 SYSTEM DESIGN

A. Seismic restraint manufacturer shall be responsible for the structural design of attachment hardware as required to attach snubbers/restraints to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.

B. The contractor shall furnish to the seismic restraint manufacturer, a complete set of approved shop drawings of all equipment which is to be restrained, from which the selection and design of seismic restraint devices and/or attachment hardware will be completed. The shop drawings furnished shall include, at a minimum, basic equipment layout, length and width dimensions, and installed operating weights of the equipment to be restrained.

C. All piping and ductwork is to be restrained to meet code requirements. At a minimum, the seismic restraint manufacturer shall provide documentation on maximum restraint spacing for various restraint sizes and anchors, as well as 'worst case' reaction loads for each restraint and/or anchor size.

D. The contractor shall ensure that all housekeeping pads used are adequately reinforced and are properly dowelled to the building structure, so as to withstand calculated seismic forces. In addition, the size of the housekeeping pad is to be coordinated with the seismic restraint manufacture to ensure that adequate edge distances exist in order to obtain desired equipment anchor capacities.

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Amber/Booth Company, Inc.
   2. The VMC Group
   3. Cooper B-Line, Inc.; a division of Cooper Industries
   4. Hilti, Inc.
   5. Kinetics Noise Control
   6. Vibration Elimination Company, Inc.
   7. Mason Industries
   8. Tolco Incorporated; a brand of NIBCO Inc.
   9. Unistrut; Tyco International, Ltd.
   10. Vibro-Acoustics
   11. M.W. Sausse & Co. Inc.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by VISCMA or an agency acceptable to authorities having jurisdiction.

C. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: ASTM A603 galvanized- or ASTM A492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

G. 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.
H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
I. Mechanical Anchor Bolts: 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 required for anchor and as tested according to ASTM E488. Minimum length of eight times diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by VISCMA or an agency acceptable to authorities having jurisdiction.
B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.
D. Refer to FEMA Manuals 412 & 414 for typical industry standard installation guidelines.

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
B. Equipment Restraints:
    1. Install resilient bold isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
    2. Install seismic-restraint devices using methods approved by VISCMA or an agency acceptable to authorities having jurisdiction providing required submittals for component.
C. Piping Restraints:
    1. Comply with requirements in MSS SP-127.
    2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
    3. Brace a change of direction longer than 12 feet (3.7 m).
D. Ductwork Restraints:
    1. Ductwork restraint not required for this project (Ductwork restraints exempt in SDC = C buildings).
E. Install cables so they do not bend across edges of adjacent equipment or building structure.
F. Install seismic-restraint devices using methods approved by VISCMA or an agency acceptable to authorities having jurisdiction, providing required submittals for component.
G. Install busing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
H. 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.
I. Drilled-in Anchors:
    1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
    2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections
   1. Tests and Inspections:
   2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
   4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
   5. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
   6. Test to 90 percent of rated proof load of device.
   7. Measure isolator restraint clearance.
   8. Measure isolator deflection.
   9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
B. Remove and replace malfunctioning units and retest as specified above.
C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust isolators after piping 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.
C. Adjust active height of spring isolators.
D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 22 05 50

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMEN

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve Tags
5. Above ceiling access T-bar markers

1.2 SUBMITTAL

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Retain and punctuate multiple material options in first subparagraph below to allow Contractor to select most cost-effective material.
2. Material and Thickness: Stainless steel, 0.025-inch (0.64-mm or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
5. Fasteners: Stainless-steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Acrylic, plastic labels for mechanical engraving, 1/4 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Engraved White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

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

and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
B. Letter Color: Red.
C. Background Color: White.
D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
G. Fasteners: Stainless-steel rivets or self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
    1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
    2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.
    1. Material: 0.032-inch- thick brass or aluminum.
    2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.5 T-BAR LABELING TAPE

A. Labeling tape shall be 1-inch wide and mounted to t-bar grid in a way that will be legible from the point of access.
B. Label Color Scheme:
    1. Plumbing : White lettering on green background to read – “Domestic Water Isolation Valve”.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Section 09 90 00 “Painting and Coating."

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:
   1. Compressed-Air Piping:
      a. Background Color: Light Gray
      b. Letter Color: White
   2. Natural Gas Piping:
      a. Background Color: Black
      b. Letter Color: White
   3. Domestic Water Piping - Cold:
      a. Background Color: Light Blue
      b. Letter Color: White.
   4. Domestic Water Piping - Hot:
      a. Background Color: Dark Blue
      b. Letter Color: White.
   5. Sanitary Waste and Storm Drainage Piping:
      a. Background Color: Brown.
      b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

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

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and as indicated in the following:
   1. Valve-Tag Size and Shape:
      a. Cold Water: 1-1/2 inches, round.
      b. Hot Water: 1-1/2 inches, round.

3.5 ABOVE CEILING ACCESS TBAR LABELS

A. Provide a label appropriate to the service being accessed above the ceiling at t-bar ceilings and access doors in hard ceilings.

END OF SECTION 22 05 53

SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes plumbing insulation for plumbing equipment, and pipe, including the following:
   1. Adjust lists below to suit Project.
   2. Insulation Materials:
      a. Glass fiber.
      b. Flexible elastomeric.
      c. Mineral fiber.
      d. Polyolefin.
      e. Polystyrene.
   3. Fire-rated insulation systems.
   4. Insulating cements.
   5. Adhesives.
   6. Mastics.
   7. Sealants.
   8. Factory-applied jackets.
   9. Field-applied fabric-reinforcing mesh.
   10. Field-applied jackets.
   11. Tapes.
   12. Securements.
   13. Corner angles.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: Show details for the following:
   1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Attachment and covering of heat tracing inside insulation.
   3. Insulation application at pipe expansion joints for each type of insulation.
   4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Removable insulation at piping specialties, equipment connections, and access panels.
   6. Application of field-applied jackets.
   7. Application at linkages of control devices.
   8. Field application for each equipment type.
C. Field quality-control inspection reports.

1.3 QUALITY ASSURANCE

A. Plumbing insulation R values shall meet this specification, Washington State Energy Code, and/or ASHRAE/IESNA 90.1 whichever is the most stringent.
B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
   2. Products: Subject to compliance with requirements, provide one of the products specified.
   3. All products shall adhere to the following restrictions
      a. Adhesives shall have a VOC content of 70 g/L or less.
      b. Mastic adhesives shall have a VOC content of 30 g/L or less.
      c. Sealants shall have a VOC content of 250 g/L or less.
   4. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   5. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSULATION MATERIALS

A. Refer to Part 3 schedule articles for requirements about where insulating materials shall be applied.
B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
F. Glass Fiber: Molded, heavy-density, one-piece insulation made from inorganic glass fibers bonded with a thermosetting resin.
   1. Products:
      a. See reference to manufacturers listed in specific insulation sections.
   2. ASTM C 547, Type I.
   3. K (ksi) value of 0.23 at 75˚ F.
   4. Pipe operating temperatures from 0˚ F to 1000˚ F.
   5. Factory-Applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
   6. Shall not promote microbial growth.
G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
   1. Products:
      a. See reference to manufacturers listed in specific insulation sections.
   2. Block Insulation: ASTM C 552, Type I.
   3. Special-Shaped Insulation: ASTM C 552, Type III.
   4. Board Insulation: ASTM C 552, Type IV.
   5. If retaining both types of insulation in first two subparagraphs below, indicate where each type applies in insulation system schedules.
   6. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.

7. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
8. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

H. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. Products:
   a. Aeroflex USA Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
1. Products:
   a. CertainTeed Corp.; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Duct Wrap.
   d. Owens Corning; All-Service Duct Wrap.

J. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
1. Products:
   a. Johns Manville; HTB 23 Spin-Glas.
   b. Owens Corning; High Temperature Flexible Batt Insulations.

K. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
1. Products:
   a. CertainTeed Corp.; Commercial Board.
   b. Johns Manville; 800 Series Spin-Glas.
   c. Knauf Insulation; Insulation Board.
   d. Owens Corning; Fiberglas 700 Series.

L. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
1. Products:
   a. Fibrex Insulations Inc.; FBX.
   b. Johns Manville; 1000 Series Spin-Glas.
   c. Owens Corning; High Temperature Industrial Board Insulations.

M. Mineral-Fiber, Preformed Pipe Insulation:
1. Products:
   a. Johns Manville; Micro-Lok.
   b. Knauf Insulation; 1000 Pipe Insulation.
   c. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

N. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-

sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

1. Products:
    a. Knauf Insulation; Permawick Pipe Insulation.
    b. Owens Corning; VaporWick Pipe Insulation.

O. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products:
    a. CertainTeed Corp.; CrimpWrap.
    b. Johns Manville; MicroFlex.
    c. Knauf Insulation; Pipe and Tank Insulation.
    d. Owens Corning; Fiberglas Pipe and Tank Insulation.

P. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Products:
    a. Armacell LLC; Tubolit.
    b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
    c. RBX Corporation; Therma-cell.

Q. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

1. Products:
    a. Dow Chemical Company (The); Styrofoam.
    b. Knauf Insulation; Knauf Polystyrene.

2.3 FIRE-RATED INSULATION SYSTEMS

A. Description: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 1-hour fire rating.

1. Products:
    a. CertainTeed Corp.; FlameChek.
    b. Johns Manville; Firetemp Wrap.
    c. Thermal Ceramics; FireMaster Duct Wrap.
    d. 3M; Fire Barrier Wrap Products.

2.4 INSULATING CEMENTS

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

1. Products:
    a. Insulco, Division of MFS, Inc.; SmoothKote.
    b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
    c. Rock Wool Manufacturing Company; Delta One Shot.

2.5 ADHESIVES AND FASTENERS

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products:

a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 81-33.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products:
a. Aeroflex USA Inc.; Aeroseal.
b. Armacell LCC; 520 Adhesive.
c. Foster Products Corporation, H. B. Fuller Company; 85-75.
d. RBX Corporation; Rubatex Contact Adhesive.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products:
a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.

E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products:
a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.

F. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products:
a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.

2.6 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates: Comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Products:
a. Childers Products, Division of ITW; CP-35.
b. Foster Products Corporation, H. B. Fuller Company; 30-90.
c. ITW TACC, Division of Illinois Tool Works; CB-50.
d. Marathon Industries, Inc.; 590.
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Products:
a. Childers Products, Division of ITW; CP-10.
b. Foster Products Corporation, H. B. Fuller Company; 35-00.
c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
d. Marathon Industries, Inc.; 550.
2. Water-Vapor Permeance: ASTM F 1249, 3 perms (2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F (Minus 29 to plus 93 deg C).
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.7 SEALANTS

A. Joint Sealants:
   1. Joint Sealants for Cellular-Glass Products:
      a. Childers Products, Division of ITW; CP-76.
      b. Foster Products Corporation, H. B. Fuller Company; 30-45.
      c. Marathon Industries, Inc.; 405.
   2. Joint Sealants for Polystyrene Products:
      a. Childers Products, Division of ITW; CP-70.
      b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
      c. Marathon Industries, Inc.; 405.
   3. Materials shall be compatible with insulation materials, jackets, and substrates.
   4. Permanently flexible, elastomeric sealant.
   5. Service Temperature Range: Minus 100 to plus 300 deg F.
   6. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:
   1. Products:
      a. Childers Products, Division of ITW; CP-76-8.
      b. Foster Products Corporation, H. B. Fuller Company; 95-44.
      c. Marathon Industries, Inc.; 405.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Products:
      a. Childers Products, Division of ITW; CP-76.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: White.

2.8 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
   4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
   5. PVDC and PVDC-SSL jackets in three subparagraphs below are proprietary products offered by Dow under the product name "Saran 540 Vapor Retarder Film" and "Saran 560 Vapor Retarder Film."
   6. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   7. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

8. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
    a. Products:
9. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
10. Vinyl Jacket: UL-rated white vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
    1. Products:
        a. Johns Manville; Zeston.
        b. P.I.C. Plastics, Inc.; FG Series.
        c. Proto PVC Corporation; LoSmoke.
    2. Adhesive: As recommended by jacket material manufacturer.
    3. Color: White.
    4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
        a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
    5. Factory-fabricated tank heads and tank side panels.
D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
    1. Products:
        a. Childers Products, Division of ITW; Metal Jacketing Systems.
        b. PABCO Metals Corporation; Surefit.
        c. RPR Products, Inc.; Insul-Mate.
    2. Sheet and roll stock ready for shop or field sizing.
    3. Finish and thickness are indicated in field-applied jacket schedules.
    4. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
    2. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
    3. Factory-Fabricated Fitting Covers:
        a. Same material, finish, and thickness as jacket.
        b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        c. Tee covers.
        d. Flange and union covers.
        e. End caps.
        f. Beveled collars.
        g. Valve covers.
        h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
E. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
    1. Products:
        a. Pittsburgh Corning Corporation; Pittwrap.
        b. Polyguard; Insulrap No Torch 125.
F. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

1. Products:
    a. Polyguard; Alumaguard 60.

G. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
1. Products:
    a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.

H. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
1. Products:
    a. Dow Chemical Company (The), Saran 560 Vapor Retarder Film.

I. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.
1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.
1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.
1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches.
2. Film Thickness: 4 mils.
3. Adhesive Thickness: 1.5 mils.
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches.

2. Film Thickness: 6 mils.
3. Adhesive Thickness: 1.5 mils.
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch in width.

2.11 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.

B. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   1. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   2. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   3. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

C. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   1. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   2. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   4. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

D. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   1. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   2. Spindle: Copper or zinc-coated, low carbon steel, Aluminum, Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   3. Adhesive-backed base with a peel-off protective cover.

E. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

F. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

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

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

2.12 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040-inch-thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 COMMON INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
B. Install insulation with tightly butted joints free of voids and gaps. Vapor barriers shall be continuous. Before installing jacket material, install vapor-barrier system.
C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
F. Install multiple layers of insulation with longitudinal and end seams staggered.
G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
H. Keep insulation materials dry during application and finishing.
I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
J. Install insulation with least number of joints practical.
K. Hangers and Anchors: Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
    1. Install insulation continuously through hangers and around anchor attachments.
    2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
    3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
    4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
M. Install insulation with factory-applied jackets as follows:
    1. Draw jacket tight and smooth.
    2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
    3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
        a. For below ambient services, apply vapor-barrier mastic over staples.
    4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
    5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

Q. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
   1. Firestopping and fire-resistive joint sealers are specified in Section 07 84 00 "Firestopping."

F. Insulation Installation at Floor Penetrations:
   1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
   2. Pipe: Install insulation continuously through floor penetrations.
   3. Seal penetrations through fire-rated assemblies according to Section 07 84 00 "Firestopping."
   4. inches o.c.

3.4 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of tank and vessel surfaces.
   2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   3. Protect exposed corners with secured corner angles.
   4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      a. Do not weld anchor pins to ASME-labeled pressure vessels.
      b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
      c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
      d. Do not over compress insulation during installation.
      e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
      f. Impale insulation over anchor pins and attach speed washers.
      g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
   6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
   7. Stagger joints between insulation layers at least 3 inches.
   8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
   9. Bevel and seal insulation end around manholes, handholes, ASME stamps, and nameplates.
   10. For equipment with surface temperatures below ambient, apply vapor-barrier mastic to open ends, joints, seams, breaks, and punctures in insulation. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
   1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
   2. Seal longitudinal seams and end joints.

3.5 PIPE INSULATION INSTALLATION

A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
B. Secure single-layer insulation with bands at 12-inch intervals and tighten bands without deforming insulation materials.
C. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with bands at 12-inch intervals.
D. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
E. Cover segmented insulated surfaces with a layer of insulating cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
F. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
G. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
H. Insulation Installation on Straight Pipes and Tubes:
    1. Secure each layer of preformed insulation to pipe with wire or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
    2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
    3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
    4. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
    5. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
I. Insulation Installation on Pipe Flanges:
    1. Install preformed pipe insulation to outer diameter of pipe flange.
    2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
    3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of same insulation material and thickness as pipe insulation.
    4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
    5. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
J. Insulation Installation on Pipe Fittings and Elbows:
    1. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
    2. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
K. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
5. Install insulation to flanges as specified for flange insulation application.

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

M. Install removable insulation covers at valves, control valves, strainers, and balancing devices. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

N. Removable lace-up canvas insulated covers may be used in-place-of hard removable covers.

O. Special Installation Requirements for Flexible Elastomeric and Polyolefin Insulation:
1. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Flanges:
   a. Install pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
3. Insulation Installation on Pipe Fittings and Elbows:

a. Install mitered sections of pipe insulation.
b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:
1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.7 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous UL-listed fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 7 Section "Through-Penetration Firestop Systems."

3.8 FINISHES

A. Equipment, and Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket as specified in Division 9 painting Sections.

1. Apply two finish coats of interior, flat, latex-emulsion size over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Do not field paint aluminum jackets.

3.9 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Inspect field-insulated equipment, randomly selected by Owners Representative, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
2. Inspect pipe, fittings, strainers, and valves, randomly selected by Owners Representative, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Remove defective Work.

C. Install new insulation and jackets to replace insulation and jackets removed for inspection. Repeat inspection procedures after new materials are installed.

3.10 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Expansion tank insulation shall be any of the following:

1. Cellular glass, 1-1/2 inches thick.
2. Flexible elastomeric, 1 inch thick.

D. Domestic Hot-Water Storage Tank Insulation: Mineral-fiber pipe and tank, 4 inches thick.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

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

1. Fire-suppression piping.
2. Drainage piping located in crawl spaces.
3. Below-grade piping.
4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 PIPING INSULATION SCHEDULE

A. Domestic hot water up to 1-1/2” inches:

1. Glass Fiber, 1 inch thick (see note 1).
2. Cellular Glass, 1 inch thick (see note 1).

B. Domestic hot water greater than 2” inches:

1. Glass Fiber, 1-1/2” inch thick (see note 1).
2. Cellular Glass, 1-1/2” inch thick (see note 1).

C. Domestic cold water:

1. Glass Fiber, ½ inch thick.
2. Cellular Glass, ½ inch thick.

D. Piping exposed to freezing without heat tracing:
1. Glass Fiber, 1-½ inch thick.
2. Cellular Glass, 1-½ inches thick.

E. Piping exposed to freezing with heat tracing:
1. Glass Fiber, 1 inch thick.
2. Cellular Glass, 1 inch thick.

F. Roof and overflow drain bodies:
1. Glass Fiber, 1 inch thick.
2. Cellular Glass, 1 inch thick.

G. All roof and overflow drainage piping:
1. Glass Fiber, 1 inch thick.
2. Cellular Glass, 1 inch thick.

H. Domestic hot water supply return up to 1-1/2 inches:
1. Glass Fiber, 1 inch thick (see note 2).
2. Cellular Glass, 1 inch thick (see note 2).

I. Domestic hot water supply return greater than 2 inches:
1. Glass Fiber, 1-1/2” inch thick (see note 2).
2. Cellular Glass, 1-1/2” inch thick (see note 2).

J. Piping Insulation Notes:
1. Runouts to fixtures which are less than 12 feet in length may have 1/2-inch insulation.
2. Runouts to fixtures which are less than 12 feet in length may have 1/2 inches insulation.
3. All insulated piping located in mechanical equipment rooms, platforms, or other accessible spaces, located below 10 ft level, shall be covered with PVC Jacketing (Addendum 4).
4. Piping in mezzanines does not require PVC jacketing (Addendum 4).

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Equipment, Outside:
1. Aluminum, stucco embossed with z-shaped locking seam, 0.040 inch thick.

D. Piping, Inside:
1. None.

E. Piping, Outside:
1. Aluminum, stucco embossed with z-shaped locking seam, 0.040-inch-thick, or approved equivalent system.

END OF SECTION 22 07 00

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY
- A. This Section includes domestic water piping inside the building.
- B. See Division 22 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
- C. See Division 22 Section "Plumbing Specialties" for water distribution piping specialties.

1.2 SUBMITTALS
- A. Field quality-control test reports.

1.3 QUALITY ASSURANCE
- A. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS
- A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- C. Hard Copper Tube: ASTM B 88, Types L water tube, drawn temper.
  1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
  2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
  3. 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.

2.2 VALVES
- A. Bronze and cast-iron, general-duty valves are specified in Division 22 Section "Valves."
- B. Balancing and drain valves are specified in Division 22 Section "Plumbing Specialties."

PART 3 - EXECUTION

3.1 EXCAVATION
- A. Excavating, trenching, and backfilling are specified in Section 31 23 00” Excavation and Fill.”

3.2 PIPE AND FITTING 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 may be used on aboveground piping, unless otherwise indicated.
- C. All piping routed inside of exterior wall, shall be Installed on the warm side of building insulation.
- D. Below ground Domestic Water Piping: Use the following piping materials for each size range:
  1. Retain one or more of three subparagraphs below. If more than one type of material and joining method is used, identify various materials on Drawings and show points of transition from one material to another.

2. NPS 1 and Smaller: Annealed copper tube, Type K; no joints.
3. NPS 1-1/4 and NPS 1-1/2: Annealed copper tube, Type K; copper pressure fittings and silver brazed joints.
4. NPS 2: Annealed copper tube, Type K; copper pressure fittings and silver brazed joints.
5. NPS 2-1/2 to NPS 3-1/2: Annealed copper tube, Type K; copper pressure fittings and silver brazed joints.
6. NPS 4 to NPS 6: Steel pipe; gray-iron, threaded fittings; and threaded joints.
7. NPS 4 to NPS 6: Annealed copper tube, Type K; copper pressure fittings and silver brazed joints.

E. Aboveground Domestic Water Piping: Use the following piping materials for each size range:
1. NPS 1” and Smaller: Drawn copper tube, Type L; copper pressure fittings; and soldered joints.
2. NPS 1-1/4 and NPS 2”: Drawn copper tube, Type L; copper pressure fittings; and soldered joints.
3. NPS 2-1/2” and above: Press fitting and joints. Manufacturer to be Viega Pro Press or approved equal.

3.3 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use bronze ball valves with threaded ends for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Install shutoff valve close to water main on each branch and riser serving equipment, on each water supply to equipment. Use ball valves for piping NPS 2 and smaller. Use butterfly valves for piping NPS 2-1/2 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
1. Install hose-end drain valves at low points in water mains, risers, and branches.
2. Install stop-and-waste drain valves where indicated.

D. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Calibrated balancing valves are specified in Division 22 Section "Plumbing Specialties."

3.4 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."

B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 22 Section "Meters and Gages," and drain valves and strainers are specified in Division 22 Section "Plumbing Specialties."

C. Install domestic water piping level without pitch and plumb.

3.5 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."

B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

C. Press fittings 2” and above.

3.6 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support devices are specified in Division 22 Section "Hangers and Supports." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs: According to the following:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Then 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Then 100 Feet: MSS Type 49, spring cushion rolls, if indicated.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 22 Section "Hangers and Supports."

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

D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   7. NPS 6: 12 feet with 3/4-inch rod.

F. Install supports for vertical steel piping every 15 feet.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   4. NPS 2-1/2: 108 inches with 1/2-inch rod.
   5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   6. NPS 6: 10 feet with 5/8-inch rod.

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

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Install piping adjacent to equipment and machines to allow service and maintenance.

B. Connect new domestic water piping to existing domestic water piping. Use transition fitting to join dissimilar piping materials.

C. Connect domestic water piping to water-service piping with shutoff valve, and extend and connect to the following:
   1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. 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 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:
   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 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:
1. See section 22 00 00, GENERAL PROVISIONS for additional requirements.
2. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
3. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
4. 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.
5. 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 too stand for four hours. Leaks and loss in test pressure 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 required corrective action.

3.9 CLEANING

A. Clean and disinfect potable domestic water piping using purging and disinfecting procedures as described in section 22 00 00, GENERAL PROVISIONS.
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.

END OF SECTION 22 11 16

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following domestic water piping specialties:
   1. Vacuum breakers.
   2. Strainers.
   3. Hose bibbs.
   4. Drain valves.
   5. Potable Water Bladder Expansion Tanks.
   6. Trap Primers.
   7. Water Hammer Arresters.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Field quality-control test reports.
C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. NSF Compliance:
   1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART - 2 PRODUCTS

2.1 VACUUM BREAKERS

A. Hose-Connection Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. MIFAB, Inc.
      b. Watts Industries, Inc.; Water Products Div.
      c. Woodford Manufacturing Company.
      d. Zurn Plumbing Products Group
   2. Standard: ASSE 1001.
   3. Body: Bronze, nonremovable, with manual drain.
   4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
   5. Finish: Chrome or nickel plated.

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 and for NPS 2-1/2 and larger.
   3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
   4. Screen: Stainless steel with round perforations, unless otherwise indicated.
   5. Perforation Size:
      a. Strainers NPS 2 and Smaller: 0.020 inch
      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 HOSE BIBBS

A. Hose Bibbs:
1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Operation for building exterior: Operating key.
15. Include operating key with each operating-key hose bibb.
16. Include integral wall flange with each chrome- or nickel-plated hose bibb.
17. Valve shall be freeze proof type. Chamber length shall be sized to accommodate wall thickness at bibb locations indicated on the drawings.

2.4 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.5 POTABLE WATER BLADDER EXPANSION TANKS

A. Bladder Expansion Tanks
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Wessels.
b. Amtrol.
c. Taco.
d. Armstrong
2. The pressurization system shall include a bladder-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure of those components.
3. The expansion tank shall be welded steel, constructed, tested and stamped in accordance with Section VIII of the ASME Code for a working pressure of 125 psig and pre-charge to the minimum operating pressure.
4. Diaphragm: Sealed into tank, flexible.

5. Tank shall be ASME rated.
6. Accessories: Pressure gauge and air-charging fitting, tank drain.
7. All wetted components shall be of FDA approved materials.

2.6 TRAP PRIMERS

A. Mechanical Type Primer – Flush valve actuated with vacuum breaker and associated chrome plated primer tubing, fittings and escutcheon.

B. Electronic Type Primer – Cast bronze construction with integral vacuum breaker, distribution header and electronic timer within surface or recessed mounted cabinet. Interlock with building EMS.

C. Automatic Type - Mechanical type that is operated off of pressure drop in water supply line of adjacent fixtures.

D. MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Sloan.
   b. Precision Plumbing Prohucts.
   c. Jay R. Smith
2. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
3. Body: Bronze or cast iron.
4. Inlet: Opening in top of body.
5. Outlet: Larger than inlet.
6. Size: Same as connected water piping and with outlet large enough for associated trap primer piping.

2.7 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. PPP Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Bellows with threaded ends.
4. If Project has more than one pump, delete paragraph and subparagraphs below and schedule pumps on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install balancing valves in locations where they can easily be adjusted.

C. All piping routed inside of exterior wall, shall be Installed on the warm side of building insulation.

D. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

E. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

F. 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 Division 22 Section "Mechanical Identification."

G. Install Water Hammer Arresters in cold water supply per manufacturers installation instructions at all restrooms with flush valves. Install Water Hammer Arresters in cold water and hot water supply serving plumbing fixtures with fast acting valves such as dishwashers and washing machines. Install Water Hammer Arresters in cold water and hot water supply serving plumbing fixtures that are remotely located.

3.2 FIELD QUALITY CONTROL

A. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

END OF SECTION 22 11 19

SECTION 22 11 20 - FUEL GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipes, tubes, and fittings.
   2. Piping specialties.
   3. Piping and tubing joining materials.
   4. Valves.
   5. Pressure regulators.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
   1. Piping and Valves: 100 psig minimum unless otherwise indicated.
   2. Service Regulators: 100 psig minimum unless otherwise indicated.

B. Fuel Gas System Pressures: Primary pressure is 2.0 psig or less.

C. Delegated Design: Design restraints and anchors for fuel-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.3 SUBMITTALS

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

B. Shop Drawings: For fuel-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Welding certificates.

D. Field quality-control reports.

E. Operation and maintenance data.

1.4 QUALITY ASSURANCE

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

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

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

D. NFPA Standard: Comply with NFPA 54, “National Fuel Gas Code.”

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
   3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
   4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
1. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Corrugated stainless-steel tubing with polymer coating.
3. Operating-Pressure Rating: 0.5 psig.
4. End Fittings: Zinc-coated steel.
5. Threaded Ends: Comply with ASME B1.20.1.
6. Maximum Length: 72 inches.

B. Y-Pattern Strainers:
1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

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

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves susceptible to tampering
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane
b. Hammond
c. Grinnell
d. Milwaukee
e. Muellar
f. Stockham
g. Watts.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.

9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for Natural-gas service with "WOG" indicated on valve body.

C. Bronze Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane
   b. Hammond
   c. Grinnell
   d. Milwaukee
   e. Muellar
   f. Stockham
   g. Watts.
   h. Lee Brass Company.
   i. McDonald, A. Y. Mfg. Co.
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for Natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. General Requirements:
1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Meter Company.
   b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   c. Maxitrol Company.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 10 psig

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging Fuel-gas piping.

B. Install underground, Fuel-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.
   1. If Fuel-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Steel Piping with Protective Coating:
   1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
   2. Replace pipe having damaged PE coating with new pipe.

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

E. Wall Pipe Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

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

G. Locate valves for easy access.

H. Install Fuel-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

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

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
   1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

O. Connect branch piping from top or side of horizontal piping.

P. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.

Q. Do not use Fuel-gas piping as grounding electrode.

R. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

S. Gas piping located in plenums or in inaccessible construction shall be welded.

3.2 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install anode for metallic valves in underground PE piping.

3.3 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Threaded Joints:
1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
D. Welded Joints:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.4 CONNECTIONS
A. Connect to utility's gas meter according to utility's procedures and requirements.
B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
C. Install piping adjacent to appliances to allow service and maintenance of appliances.
D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.5 LABELING AND IDENTIFYING
A. Comply with requirements in Division 23 Section "Mechanical Identification" for piping and valve identification.

3.6 FIELD QUALITY CONTROL
A. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
B. Fuel-gas piping will be considered defective if it does not pass tests and inspections.

3.7 OUTDOOR PIPING SCHEDULE
A. Underground Fuel-gas piping shall be the following:
1. Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
B. Aboveground Fuel-gas piping shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.8 INDOOR PIPING SCHEDULE
A. Aboveground Fuel-gas piping shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints for pipe 2” and smaller.
2. Steel pipe with wrought-steel fittings and welded joints for pipe 2-1/2” and larger.

3.9 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE
A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.

2. Bronze plug valve.

B. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.

3.10 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Section 01 9113 – General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, text development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 22 11 20

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY
- A. This Section includes the following soil and waste, sanitary drainage and vent piping inside the building:
  1. Pipe, tube, and fittings.
  2. Special pipe fittings.

1.2 PERFORMANCE REQUIREMENTS
- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
  1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.3 SUBMITTALS
- A. Field quality-control inspection and test reports.

1.4 QUALITY ASSURANCE
- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS
- A. Sanitary Waste and Vent Piping (Above Grade)
  1. Pipe: ASTM A-888, no hub, cast iron. CISPI Standard 301, twice bituminous coated. Pipe showing rust or cracks in coating shall be removed and replaced. Tyler or Charlotte.
     a. Fittings:
        1) Above-Grade No-Hub Joints (Above 12 inches from grade): Manufactured by Clamp-All, Tyler or Charlotte. Stainless steel shield with 4 or 6 bands and neoprene gasket conforming to ASTM C-564, CISPI 301.Hubless Cast-Iron Pipe and Fittings: ASTM A 888 or CISPI 301.

- B. Acid Resistant Sanitary Waste and Vent Piping (Above Grade)
  1. Pipe: ASTM Cell Class 23447, CPVC Schedule 40 NFS-cw, ASTM F 2618. Manufactured by Charlotte.
     a. Fittings:
        1) CPVC Schedule 40 drainage pattern, ASTM F 2618 and ASTM F 493 with solvent welded fittings and joints: Manufactured by Charlotte.

- C. Note: CPVC piping located in plenum spaces shall either meet the requirements of the flame spread/ smoke developed rating for plenum spaces or be completely wrapped by insulating system meeting the requirements of the flame spread/ smoke developed rating for installation within plenum spaces.

- D. Note: Acid Resistant Waste and Vent piping shall serve all plumbing fixtures located within the Science Class rooms Acid Resistant piping shall route minimum 5’-0” after last fixture served before connecting to Non-Acid resistant waste piping. Acid resistant Vent piping shall serve only the fixtures indicated above and shall terminate at the roof separately from Non-Acid Resistant Vent piping.

E. Sanitary Waste and Vent Piping (Below Grade)
1. Pipe: ASTM A-888, no hub, cast iron. CISPI Standard 301, twice bituminous coated. Pipe showing rust or cracks in coating shall be removed and replaced. Tyler or Charlotte.
a. Fittings:
1) No-Hub Joints (Heavy Duty, Manufactured by Clamp-All, Tyler or Charlotte. Conforming to ASTM C-564, CISPI 301 and FM 1680 standards. Stainless steel shield with 4 or 6 band neoprene gaskets.
2. PVC Pipe: ASTM D 2665, Schedule 40 Solid-wall drain, waste and vent (Below grade up to 12 inches above grade):
a. Fittings:
1) ASTM D 2665 PVC socket type fittings, made to ASTM D 3311, drain, waste and vent patterns. Solvent-cement joints.

F. Acid Resistant Sanitary Waste and Vent Piping (Below Grade)
Pipe: ASTM Cell Class 23447, CPVC Schedule 40 NFS-cw, ASTM F 2618 and ASTM D 2321 and ASTM F 1668. Manufactured by Charlotte.
a. Fittings:
1) CPVC Schedule 40 drainage pattern, ASTM F 2618 and ASTM F 493 with solvent welded fittings and joints: Manufactured by Charlotte.

G. Note: Acid Resistant Waste and Vent piping shall serve all plumbing fixtures located within the Science Class rooms Acid Resistant piping shall route minimum 5'-0" after last fixture served before connecting to Non-Acid resistant waste piping. Acid resistant Vent piping shall serve only the fixtures indicated above and shall terminate at the roof separately from Non-Acid Resistant Vent piping.

PART 3 - EXECUTION

3.1 EXCAVATION
A. Excavating, trenching, and backfilling are specified in Section 31 23 00" Excavation and Fill."

3.2 PIPING APPLICATIONS
A. Special pipe fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
B. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

3.3 PIPING INSTALLATION
A. Basic piping installation requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."
B. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
C. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
D. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
E. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.

2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

F. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

G. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

H. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."

B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
2. Hubless Joints: Make with rubber gasket and sleeve or clamp.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Mechanical Vibration and Seismic Controls."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports." Install the following:
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 Section "Hangers and Supports."

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

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.

I. Install supports for vertical steel piping every 15 feet.

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

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.

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

L. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

B. Connect drainage and vent piping to the following:

1. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Specialties."
2. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection.

3.7 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. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction.

1. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
2. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 13 16

SECTION 22 13 19 - SANITARY WASTE AND VENT PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following drainage piping specialties:
   1. Floor drains/Floor sink.
   2. Miscellaneous drainage piping specialties.
   3. Cleanouts.
   4. Air-gap Fittings.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 FLOOR DRAINS/FLOOR SINKS

A. Cast-Iron Floor Drains:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      b. Zurn Plumbing Products Group.
      c. MIFAB
      d. Sioux Chief
   2. Standard: ASME A112.6.3.
   3. Body Material: Gray iron.
   4. Seepage Flange: Required.
   5. Clamping Device: Required.
   6. Outlet: Bottom.
   7. Top or Strainer Material: Nickel bronze.
   8. Top of Body and Strainer Finish: Polished bronze or Rough bronze as indicated.
   9. Top Shape: Round or Square.
   10. Funnel: See Drawing Schedule.
   11. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
   12. Floor sinks shall be square with grate as specified, see schedule.

2.2 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
   2. Body: Bronze or cast iron.
   3. Inlet: Opening in top of body.
   4. Outlet: Larger than inlet.
   5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

2.3 CLEANOUTS

A. General: Cleanouts shall be heavy iron bodies with taper thread-bronze plugs. They shall be full size of the pipe to 4” and not less than 4” for larger pipe. Cleanout extension shall have flush frames and brass removable cover plates. Extension to floor shall be made by using 1/8 bends.

B. Floor Cleanouts
   1. Coated cast iron body, heavy duty nickel bronze top, fully adjustable and secured to body. Gasket sealed iron closure plug.
   2. Cleanouts installed above grade shall have flange and flashing clamp.
   3. Cleanouts in tiled terrazzo or similar paved floors: J.R. Smith #4180.
   4. Cleanouts installed in ceramic tile floors: J.R. Smith #4040.
   5. Cleanouts installed in floors with asphalt, vinyl or linoleum: J.R. Smith #4140.
   6. Cleanouts in carpeted areas shall be furnished with carpet marker: J.R. Smith #4160.
   7. Cleanouts in unfinished areas shall have heavy duty cast iron covers.
   8. All cleanouts shall have vandal-proof screws.
   9. Cleanouts in other finished areas shall have round tops.

C. Wall Cleanouts
   1. Coated cast iron cleanout tee. Gasket sealed iron plug. Shallow type, round, stainless steel wall cover with center vandal-proof screw.

D. MANUFACTURERS
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. J.R. Smith.
      b. Sloan.
      c. Zurn.
      d. Precision Plumbing Products.
      e. MIFAB.
      f. Sioux Chief

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

C. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.

D. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

E. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
F. Retain first paragraph below to reduce vandalism.
G. Install vent caps on each vent pipe passing through roof.
H. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
I. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.
J. Install cleanouts in above round piping and building drain piping according to the following, unless otherwise indicated:
    1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
    2. Locate at each change in direction of piping greater than 45 degrees.
    3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
    4. Locate at base of each vertical soil and waste stack.
K. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
L. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

3.2 CONNECTIONS
A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.

3.3 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 22 13 19

SECTION 22 14 13 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY
- A. This Section includes the following storm drainage piping inside the building.
  1. Pipe, tube, and fittings.
  2. Special pipe fittings.

1.2 PERFORMANCE REQUIREMENTS
- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
  1. Storm Drainage Piping: 10-foot head of water.

1.3 SUBMITTALS
- A. Field quality-control inspection and test reports.

1.4 QUALITY ASSURANCE
- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS
- A. Storm Drain Piping (Above Grade)
  1. Pipe: ASTM A-888, no hub, cast iron. CISPI Standard 301, twice bituminous coated. Pipe showing rust or cracks in coating shall be removed and replaced. Tyler or Charlotte.
     a. Fittings:
        1) No-Hub Joints (Above 12 inches from grade): Manufactured by Clamp-All, Tyler or Charlotte. Stainless steel shield with 4 or 6 bands and neoprene gasket conforming to ASTM C-564, CISPI 301.Hubless Cast-Iron Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Storm Drain Piping (Below Grade)
  1. Pipe: ASTM A-888, no hub, cast iron. CISPI Standard 301, twice bituminous coated. Pipe showing rust or cracks in coating shall be removed and replaced. Tyler or Charlotte.
     a. Fittings:
        1) No-Hub Joints Heavy Duty, Manufactured by Clamp-All, Tyler or Charlotte. Conforming to ASTM C-564, CISPI 301 and FM 1680 standards. Stainless steel shield with 4 or 6 band neoprene gaskets.

  2. Pipe: ASTM D1785, Schedule 40 PVC solid wall (Below grade up to transition at slab level). Pipe shall be domestically produced of virgin resin and carry the IAPMO and NSF seals.
     a. Fittings:
        1) ASTM D2467 socket joints. Joints: Solvent weld with NSF cement and purple primer of type and viscosity appropriate for weather conditions and size of pipe.0

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavating, trenching, and backfilling are specified in Section 31 23 00” Excavation and Fill.”

3.2 PIPING APPLICATIONS

A. Special pipe fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

3.3 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Section 33 40 00 “Storm Drainage Utilities.”
B. Basic piping installation requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."
C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Plumbing Specialties."
D. Install wall-penetration-fitting system at each service pipe penetration through foundation wall. Make installation watertight.
E. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
F. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
G. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
H. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
    1. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow for 3” and smaller. 1 percent downward in direction of flow for 4” and larger.
I. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
J. Install underground PVC storm drainage piping according to ASTM D 2321.
K. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."
B. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
C. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
D. PVC Non-pressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports." Install the following:
    1. Vertical Piping: MSS Type 8 or Type 42, clamps.
    2. Individual, Straight, Horizontal Piping Runs: According to the following:
        a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
        b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

B. Install supports according to Division 22 Section "Hangers and Supports."
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6: 60 inches with 3/4-inch rod.
   5. Spacing for 10-foot lengths may be increased to 10 feet spacing for fittings is limited to 60 inches.
F. Install supports for vertical cast-iron soil piping every 15 feet.
G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS
A. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
B. Connect storm drainage piping to roof drains and storm drainage specialties.

3.7 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. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
D. Test storm drainage piping according to procedures of authorities having jurisdiction.

3.8 CLEANING
A. Clean interior of piping. Remove dirt and debris as work progresses.
B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 14 13

SECTION 22 14 23 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following storm drainage piping specialties:
   1. Cleanouts.
   2. Roof drains.
   3. Miscellaneous storm drainage piping specialties.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Cast-Iron Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      b. Watts Drainage Products Inc.
      c. Sioux Chief
   2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
   3. Size: Same as connected drainage piping
   4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
   5. Closure: Countersunk, brass plug.
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
   7. Top Loading Classification: Heavy Duty.

B. Cast-Iron Floor Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      b. Watts Drainage Products Inc.
      c. Sioux Chief
   2. Standard: ASME A112.36.2M for adjustable housing cleanout.
   3. Size: Same as connected branch.
   4. Type: Adjustable housing.
   5. Body or Ferrule: Cast iron.
   6. Closure: Brass plug with straight threads and gasket or Brass plug with tapered threads.
   7. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
   8. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
   9. Frame and Cover Shape: Round or Square in tiled floor areas.
   10. Top Loading Classification: Heavy Duty.
   11. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
   12. Basis of design:
      a. Tiled terrazzo or similar floors – J.R. Smith Fig. 4180.
      b. Ceramic tile floors – J.R. Smith Fig. 4040.
      c. Asphalt, vinyl, or linoleum floors – J.R. Smith Fig 4140.

d. Carpeted floors - J.R. Smith Fig. 4160.

C. Cast-Iron Wall Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
b. Watts Drainage Products Inc.
c. Sioux Chief
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, stainless-steel cover plate with vandal-proof screw.

2.2 ROOF DRAINS

A. Roof Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
b. Watts Drainage Products Inc.
c. Sioux Chief
2. Metal Roof Drains:
a. Pattern: Roof drain.
b. Body Material: Cast Iron.
c. Dimensions of Body: See drawings.
d. Combination Flashing Ring and Gravel Stop: Required.
e. Flow-Control Weirs: Not required.
f. Outlet: Bottom.
g. Dome Material: Polyethylene.
h. Extension Collars: verify.
i. Underdeck Clamp: required.
j. Sump Receiver: required.

2.3 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Boots
1. Description: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.
2. Size: Same as or larger than connected downspout.

B. Conductor Nozzles:
1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
E. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roof materials are specified in Division 7.
   1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Position roof drains for easy access and maintenance.
F. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
G. Install cast-iron soil pipe downspout boots at grade with top of hub 12 inches above grade.
H. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
I. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS
A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION
A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
C. Set flashing on floors and roofs in solid coating of bituminous cement.
D. Secure flashing into sleeve and specialty clamping ring or device.

3.4 PROTECTION
A. Protect drains during the 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 22 14 23

SECTION 22 15 13 - GENERAL-SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes piping and related specialties for general-service compressed-air systems operating at 150 psig or less.

B. See Section 22 15 19 - General-Service Packaged Air Compressors and Receivers, for general-service air compressors and accessories.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Compressed-air piping and support and installation shall withstand effects of seismic events determined according to SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Piping and fittings.
   2. Dielectric fittings.
   3. Flexible connectors.
   4. Pressure regulators. Include rated capacities and operating characteristics.
   5. Automatic drain valves.
   6. Filters. Include rated capacities and operating characteristics.
   7. Lubricators. Include rated capacities and operating characteristics.

B. Field quality-control test reports.

C. Operation and maintenance data.

D. Warranty.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Tube: ASTM B88, Type L seamless, drawn-temper, water tube.
   1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
   2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
   3. Copper Unions: ASME B16.22 or MSS SP-123.

B. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.
   1. ASME B16.21, nonmetallic, flat, full-face, asbestos free, 1/8-inch maximum thickness.

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

C. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

2.3 VALVES

A. Bronze Ball, Butterfly, Check, Gate, and Globe Valves: Comply with requirements in Section 22 05 23 - General-Duty Valves for Plumbing Piping.

2.4 DIELECTRIC FITTINGS

A. General Requirements for Dielectric Fittings: Combination fitting of copper alloy and ferrous materials with insulating material; suitable for system fluid, pressure, and temperature. Include threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

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

2.5 FLEXIBLE PIPE CONNECTORS

A. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: 200 psig minimum.
   2. End Connections, NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.

B. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: 200 psig minimum.
   2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.

2.6 SLEEVES

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

2.7 ESCUTCHEONS

A. General Requirements: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

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

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

D. One-Piece, Stamped-Steel Escutcheons: With set screw and chrome-plated finish.

E. One-Piece, Floor-Plate Escutcheons: Cast iron.

2.8 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.
   1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Main Pressure Regulators: Bronze body, pilot-operated direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250-psig inlet pressure, unless otherwise indicated.
   1. Pressure regulators to be sized no-more-than two pipe sizes smaller than the line they are being installed in with a maximum of 10 psi drop across the valve.

C. Air-Line Pressure Regulators: Diaphragm or pilot operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.

D. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate.

E. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded.

F. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock.

2.9 QUICK COUPLINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aeroquip Corporation; Eaton Corp.

2. Bowes Manufacturing Inc.
3. Foster Manufacturing, Inc.
4. Milton Industries, Inc.
5. Parker Hannifin Corp.; Fluid Connectors Group; Quick Coupling Div.
6. Rectus Corp.
7. Schrader-Bridgeport; Amflo Div.
8. Schrader-Bridgeport/Standard Thomson.
9. Snap-Tite, Inc.; Quick Disconnect & Valve Division.
10. TOMCO Products Inc.
11. Tuthill Corporation; Hansen Coupling Div.

B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

C. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
2. Plug End: check-valve type with barbed outlet for attaching hose.

D. Valve-less Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.
1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
2. Plug End: With barbed outlet for attaching hose.

2.10 HOSE ASSEMBLIES

A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psig minimum working pressure, unless otherwise indicated.
1. Hose: Reinforced single or double wire-braid, CR-covered hose for compressed-air service.
2. Hose Clamps: Stainless-steel clamps or bands.
3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
4. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

2.11 HOSE REELS

A. Description: Open hose reel with hose, hose stop, heavy duty frame with mounting base, adjustable guide arm, open hose reel, and fully enclosed spring operated hose retraction mechanism.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Compressed-Air Piping between Air Compressors and Receivers: Use the following piping materials for each size range:
1. NPS 2 and Smaller: Type L, copper tube; wrought-copper fittings; and brazed joints.

B. Low-Pressure Compressed-Air Distribution Piping: Use the following piping materials for each size range:
1. NPS 2 and Smaller: Type L, copper tube; wrought-copper fittings; and brazed joints.

C. Drain Piping: Use the following piping materials:
1. NPS 2 and Smaller: Type M, copper tube; wrought-copper fittings; and brazed or soldered joints.

3.2 VALVE APPLICATIONS

A. Comply with requirements in Section 22 05 23 - General-Duty Valves for Plumbing Piping.

B. Equipment Isolation Valves: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
B. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.
C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.
E. Install piping adjacent to equipment and machines to allow service and maintenance.
F. Install air and drain piping with 1 percent slope downward in direction of flow.
G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.
H. Equipment and Specialty Flanged Connections:
    1. Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.
I. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
J. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."
K. Install piping to permit valve servicing.
L. Install piping free of sags and bends.
M. Install fittings for changes in direction and branch connections.
N. Install seismic restraints on piping. Seismic-restraint devices are specified in Section 22 05 50 – Plumbing Seismic Controls.
O. Install unions, adjacent to each valve and at final connection to each piece of equipment and machine.

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from pipe and fittings before assembly.
C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Apply appropriate tape or thread compound to external pipe threads.
D. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
E. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Join according to ASTM B828 or CDA's "Copper Tube Handbook."(Drain piping only)
F. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
G. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.5 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Section 22 05 23 - General-Duty Valves for Plumbing Piping.
B. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.
C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.
D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.6 DIELECTRIC FITTING INSTALLATION

A. Install dielectric unions in piping at connections of dissimilar metal piping and tubing.

3.7 FLEXIBLE PIPE CONNECTOR INSTALLATION

A. Install flexible pipe connectors in discharge piping of each air compressor.
B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.
C. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

3.8 SPECIALTY INSTALLATION

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.
B. Install air-main pressure regulators in compressed-air piping at or near air compressors.
C. Install air-line pressure regulators in branch piping to equipment.
D. Install automatic drain valves on after coolers, receivers, and dryers. Discharge condensate onto nearest floor drain.
E. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters. Mount on wall at locations indicated.
F. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated.
G. Install quick couplings at piping terminals for hose connections.
H. Install hose assemblies at hose connections.

3.9 SLEEVE INSTALLATION

A. Install sleeves for pipes passing through concrete and masonry walls, gypsum board partitions, and concrete floor and roof slabs using galvanized-steel pipe.
B. Install sleeves in new walls and slabs as new walls and slabs are constructed.
C. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use Steel Pipe Sleeves.
D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07, Section "Penetration Firestopping."

3.10 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
B. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
C. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish with set screw.
D. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
E. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
F. Bare Piping in Equipment Rooms: One piece, stamped steel with set screw.
G. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.11 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Section 22 05 50 – Plumbing Seismic Controls, for seismic-restraint devices.
B. Comply with requirements in Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment, for pipe hanger and support devices.
C. Vertical Piping: MSS Type 8 or 42, clamps.
D. Individual, Straight, Horizontal Piping Runs:
    1. 100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.
    2. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
F. Base of Vertical Piping: MSS Type 52, spring hangers.

G. Support horizontal piping within 12 inches of each fitting and coupling.
H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
    1. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
    2. NPS 3/4: 84 inches with 3/8-inch rod.
    3. NPS 1: 96 inches with 3/8-inch rod.
    4. NPS 1-1/4: 108 inches with 3/8-inch rod.
    5. NPS 1-1/2: 10 feet with 3/8-inch rod.
    6. NPS 2: 11 feet with 3/8-inch rod.
J. Install supports for vertical copper tubing every 10 feet.

3.12 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Section 22 05 53 - Identification for Plumbing Piping and Equipment.

3.13 FIELD QUALITY CONTROL

A. Perform field tests and inspections.
B. Tests and Inspections:
    1. Piping Leak Tests: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
    2. Repair leaks and retest until no leaks exist.
    3. Inspect filters lubricators and pressure regulators for proper operation.

END OF SECTION 22 15 13

SECTION 22 15 19 – GENERAL SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Oil-flooded, rotary-screw air compressors.
   2. Inlet-air filters.
   3. Air-cooled, compressed-air aftercoolers.
   4. Refrigerant compressed-air dryers.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design compressed-air equipment mounting, including comprehensive engineering analysis by a qualified professional District Representative, using performance requirements and design criteria indicated.

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

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Wiring Diagrams: For power, signal, and control wiring.

B. Delegated-Design Submittal: For compressed-air equipment mounting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional District Representative responsible for their preparation.
   1. Detail fabrication and assembly of supports.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

C. Seismic Qualification Certificates: For compressed-air equipment, accessories, and components, from manufacturers.

D. Operation and maintenance data.

E. Warranty.

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. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND RECEIVERS

A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
   1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
   2. Motor Controllers: Full-voltage, combination magnetic type with under voltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.

3. Control Voltage: 120-V ac or less, using integral control power transformer.
4. Motor Overload Protection: Overload relay in each phase.
5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
6. Automatic control switches to start/stop air compressor.
7. Instrumentation: Include discharge-air pressure gage, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gages, and control transformer.
8. Alarm Signal Device: For connection to DDC system to indicate when air compressor fails to operate.

C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII.
1. Pressure Rating: At least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.
2. Interior Finish: Corrosion-resistant coating.
3. Accessories: Include safety valve, pressure gage, drain, and pressure-reducing valve.

D. Mounting Frame: Fabricate mounting and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.2 OIL-INJECTED, ROTARY-SCREW AIR COMPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
1. Atlas Copco.
2. Ingersoll-Rand; Air Solutions Group.
3. Rogers Machinery

B. Compressor(s): Oil-Injected, rotary-screw.
1. Coupling: Non-lubricated, flexible type.
2. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package pre-piped to unit; with air pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal bypass valve.
3. Air Filter: Dry type, with maintenance indicator and cleanable replaceable filter element.
4. Air/Coolant Receiver and Separation System: 150 psig rated steel tank with ASME safety valve, coolant-level gage, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal bypass valve.
5. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between 50 and 100 psig. Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

C. Capacities and Characteristics:
1. Air Compressor(s): One or two stage.
2. Standard-Air Capacity of Air Compressor: 28-75 scfm.
3. Discharge-Air Pressure: 100 psig.
4. Motor :
   a. Horsepower: 20 hp.
   b. Speed: variable
5. Unit Electrical Characteristics:
   a. Volts: 460.
   b. Phase(s): Three.
   c. Hertz: 60 Hz.
6. Receiver: ASME construction steel tank.
   a. Arrangement: Horizontal.
   b. Capacity: 120 gal.
   c. Interior Finish: Epoxy or galvanized coating.
   d. Pressure Rating: 125 psig minimum.

e. Pressure Regulator Setting: 100 psig.
f. Pressure Relief Valve Setting: 125 psig.
g. Drain: Automatic valve.

7. Enclosure: Steel with sound-attenuating material lining.

2.3 INLET-AIR FILTERS

A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.
1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

B. Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.
1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match total capacity of connected air compressors, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.4 AIR-COOLED, COMPRESSED-AIR AFTERCOOLERS

A. Integral to unit.

2.5 REFRIGERANT COMPRESSED-AIR DRYERS

A. Integral to unit.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 – Motors and Drives.
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 Division 26 Sections.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Equipment Mounting: Install air compressor on concrete bases using elastomeric pads or mounts. Comply with requirements in Division 03, Section “Cast-in-Place Concrete”. Comply with requirements for vibration isolation devices specified in Section 22 05 50 – Plumbing Seismic Controls.
1. Minimum Deflection: 1/4 inch in 1 inch

B. Install compressed-air equipment anchored to substrate.

C. Install the following devices on compressed-air equipment:
1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
2. Pressure Regulators: Install downstream from air compressors.
3. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

D. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check for lubricating oil in lubricated-type equipment.
3. Check belt drives for proper tension.
4. Verify that air-compressor inlet filters and piping are clear.
5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.

6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure but not higher than rating of system components.
7. Check for proper seismic restraints.
8. Drain receiver tanks.
9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
10. Test and adjust controls and safeties.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 15 13 - General-Service Compressed-Air Piping. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

3.3 IDENTIFICATION

A. Identify general-service air compressors and components. Comply with requirements for identification specified in Section 22 05 53 - Identification for Plumbing Piping and Equipment.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train District's maintenance personnel to adjust, operate, and maintain air compressors.

END OF SECTION 22 15 19

SECTION 22 31 00 - WATER SOFTENERS

PART 1 - GENERAL

1.1 SUMMARY
- A. This Section includes commercial water softeners.
  1. Chemicals.
  2. Water testing kits.

1.2 SUBMITTALS
- A. Product Data: For each type of water softener and water testing kit indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and connections to piping systems.
  1. Include piping diagrams.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

1.3 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.

1.4 WARRANTY
- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softener that fail in materials or workmanship within specified warranty period.
  1. Water Softener, Warranty Period: Five years from date of Substantial Completion.

1.5 EXTRA MATERIALS
- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Salt for Brine Tanks: Furnish same form as and at least four times original load, but not less than 200 lb. Deliver on pallets in 40- or 50-lb packages. Coordinate with owner.
  2. Store salt on raised platform where directed by Owner. Do not store in contact with concrete floor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 COMMERCIAL WATER SOFTENERS
- A. Description: Factory-assembled, pressure-type water softener.
  1. Coordinate first subparagraph and list below with Part 2 "Manufacturers" Article. Retain "Available" for nonproprietary and delete for semiproprietary specifications.
  2. Manufacturers:
     a. Culligan
     b. Water Soft, Inc.
     c. King Soft, Inc.

d. North Star
3. Comply with NSF 61, "Drinking Water System Components--Health Effects."
4. Configuration: Twin unit with two mineral tanks and one brine tank.
5. Media Vessel:
a. Construction: Polyglass.
b. Pressure Rating: 35-125 psig.
c. Wetted Components: Suitable for water temperatures from to at least 120 deg F.
d. Media Vessel size: See schedule on the drawings
6. Controls: Fully automatic.
a. Automatic, non-electric operation.
b. Metered, demand-operated control valve.
7. Brine Tank: Combination measuring and wet-salt storing system.
a. Tank and Cover Material: HDPE.
b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
c. Size: see schedule on the drawings

B. Capacity and Characteristics:
1. Service: Cold water.
2. Continuous Service Flow Rate: 65 GPM at 15 PSID
3. Peak Service Flow Rate: 85 GPM at 25 PSID
4. Water Meter Size: 2”
5. Manifold Pipe Size: 2”
6. Backwash to Drain Pipe Size: 2”
7. Number of Mineral Tanks: One
8. Salt Capacity: 7.0 C/FT

2.3 CHEMICALS

A. Salt for Brine Tanks: High-purity sodium chloride; free of dirt and foreign material. Rock and granulated forms are not acceptable.
1. Form: Processed, food-grade salt pellets.

2.4 WATER TESTING SETS

A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Install concrete bases of dimensions indicated for commercial water softeners. Refer to Division 22 Section "Basic Mechanical Materials and Methods."

3.2 WATER SOFTENER INSTALLATION

A. Install commercial water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
B. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.
C. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
D. Install water testing sets mounted on wall, unless otherwise indicated, and near water softeners.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.
C. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings. Dielectric fittings are specified in Division 22 Section "Basic Mechanical Materials and Methods."
D. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.
   1. Metal general-duty valves are specified in Division 22 Section "Valves."
   2. Plastic valves are specified in Division 22 Section "Domestic Water Piping."
   3. Exception: Water softeners with factory-installed shutoff valves at locations indicated.
E. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."
   1. Exception: Water softeners with factory-installed pressure gages at locations indicated.
   2. Exception: Household water softeners.
F. Install valved bypass water piping around water softeners.
   1. Metal general-duty valves are specified in Division 22 Section "Valves."
   2. Plastic valves are specified in Division 22 Section "Domestic Water Piping."
   3. Water piping is specified in Division 22 Section "Domestic Water Piping."
   4. Exception: Household water softeners.
G. Install drains as indirect wastes to spill into open drains or over floor drains.

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. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After piping connections have been made and system has been energized, start units to confirm proper unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
C. Remove and replace malfunctioning water softeners that do not pass tests and inspections and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
B. Add water to brine tanks and fill with salt.
   1. Commercial Water Softeners: Food-grade salt pellets.
C. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
   1. Revise list below to suit Project.
   2. ASTM D 859, "Test Method for Silica in Water."
   3. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
   4. ASTM D 1068, "Test Methods for Iron in Water."
   5. ASTM D 1126, "Test Method for Hardness in Water."
   6. ASTM D 1129, "Terminology Relating to Water."
   7. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water softeners. Refer to Section 01 79 00 Demonstration and Training."

END OF SECTION 22 31 00

22 34 00 - FUEL-FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY
- A. This Section includes the following fuel-fired water heaters:
  1. Commercial, direct-vent, vertical storage, gas water heaters.
  2. Water heater accessories.

1.2 SUBMITTALS
- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and maintenance data.
- D. Warranty.

1.3 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. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

1.4 WARRANTY
- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired water heaters that fail in materials or workmanship within specified warranty period.
  1. Failures include, but are not limited to, the following:
     a. Structural failures.
     b. Faulty operation of controls.
     c. Deterioration of metals, metal finishes, and other materials beyond normal use.
  2. Warranty Period(s): From date of Substantial Completion:
     a. Commercial, Gas Water Heaters: Five years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 COMMERCIAL, GAS WATER HEATERS
- A. Commercial, direct-vent, water tube, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.
  1. Manufacturers:
     a. A.O. Smith
     b. Reehm/Ruud
     c. Bradford White
     d. Lochinvar Shield
  2. Factory-Installed Appurtenances:

a. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
b. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
c. Jacket: Steel with enameled finish.
d. Heat Exchanger: For use with direct-vent, water tube, water heaters and for natural-gas fuel.
e. Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.
f. Temperature Control: Adjustable thermostat.
g. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
h. Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

3. Special Requirements: NSF 5 construction.
4. Energy Management System Interface: Normally closed dry contacts for enabling and disabling water heater.

2.3 WATER HEATER ACCESSORIES

A. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.
B. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.
C. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.
D. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install commercial water heaters on concrete bases.
1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
2. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
C. Install gas water heaters according to NFPA 54.
1. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas water heaters, if required for operation of safety control.
D. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial, water-heater, relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
E. Install water heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
F. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
G. Fill water heaters with water.

3.2 CONNECTIONS

A. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
B. Ground equipment according to Section 26 05 26 “Grounding and Bonding.”
C. Connect wiring according to Division 26.

3.3 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to inspect installation, including connections.
B. Perform the following field tests and inspections:
    1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
    2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
    3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water heaters. Refer to Section 01 79 00 “Demonstration and Training.”

END OF SECTION 22 34 00

SECTION 22 40 00 - PLUMBING FIXTURES

PART - 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Faucets.
   2. Flushometers.
   3. Toilet seats.
   4. Protective shielding guards.
   5. Fixture supports.
   6. Water closets.
   7. Urinals.
   8. Lavatories.
   9. Drinking Fountains/Water Coolers Bottle Fillers
   10. Shower Valves.
   11. Sinks.
   12. Service sinks.
   13. Dishwasher Air Gap Fitting.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.
B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
C. FRP: Fiberglass-reinforced plastic.
D. PMMA: Polymethyl methacrylate (acrylic) plastic.
E. PVC: Polyvinyl chloride plastic.
F. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Operation and maintenance data.

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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
F. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
G. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants" for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.

H. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   2. Plastic Shower Enclosures: ANSI Z124.2.
   3. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
   4. Slip-Resistant Bathing Surfaces: ASTM F 462.
   5. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
   6. Stainless-Steel Residential Sinks: ASME A112.19.3.
   7. Vitreous-China Fixtures: ASME A112.19.2M.
   8. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

I. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
   2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
   3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
   4. Faucets: ASME A112.18.1.
   5. Hose-Connection Vacuum Breakers: ASSE 1011.
   6. Hose-Coupling Threads: ASME B1.20.7.
   7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
   8. NSF Potable-Water Materials: NSF 61.
   9. Pipe Threads: ASME B1.20.1.
   10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
   11. Supply Fittings: ASME A112.18.1.
   12. Brass Waste Fittings: ASME A112.18.2.

J. Comply with the following applicable standards and other requirements specified for bathtub and/or shower faucets:
   1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
   2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
   3. Faucets: ASME A112.18.1.
   4. Hand-Held Showers: ASSE 1014.
   5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
   6. Hose-Coupling Threads: ASME B1.20.7.
   7. Manual-Control Antiscald Faucets: ASTM F 444.
   8. Pipe Threads: ASME B1.20.1.
   9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
   10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
   11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

K. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   1. Atmospheric Vacuum Breakers: ASSE 1001.
   2. Brass and Copper Supplies: ASME A112.18.1.
   3. Manual-Operation Flushometers: ASSE 1037.
   4. Plastic Tubular Fittings: ASTM F 409.
   5. Brass Waste Fittings: ASME A112.18.2.
   6. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

L. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Flexible Water Connectors: ASME A112.18.6.
   2. Grab Bars: ASTM F 446.
   3. Hose-Coupling Threads: ASME B1.20.7.
   4. Off-Floor Fixture Supports: ASME A112.6.1M.
   5. Pipe Threads: ASME B1.20.1.
   6. Plastic Toilet Seats: ANSI Z124.5.
   7. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART - 2 PRODUCTS

2.1 SINK/LAVATORY FAUCETS

A. Faucets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Chicago Faucets
   b. Sloan Valve Company
   c. Elkay
2. Description: Faucets shall be chrome plated solid brass construction. Type as scheduled on the drawings. Faucets for sinks shall have a maximum flow rate of 2.0 GPM. Faucets for lav's shall have a maximum flow rate of 0.5 GPM.

2.2 FLUSHOMETERS

A. Flushometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Sloan Valve Company.
2. Description: Flushometer for urinals and water-closet type fixtures. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts with dual filtered by pass.
3. Flushometers for water closets to be manually operated with a consumption rate of 1.6 gallons per flush.
4. Flushometers for urinals to be manually operated with a consumption rate of .125 gallons per flush.

2.3 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Bemis Manufacturing Company.
   c. Church Seats.
   d. Kohler Co.
   e. Olsonite Corp.
2. Select from list below for standard and heavy-duty, commercial toilet seats.
3. Description: Toilet seat for water-closet-type fixture.

   a. Material: Molded, solid plastic with antimicrobial agent.
   b. Configuration: Open front with without cover.
   c. Size: Elongated.
   d. Class: Standard commercial.
   e. Color: White.
   f. Check hinge

2.4 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. McGuire Manufacturing Co., Inc.
   b. TRUEBRO, Inc.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.5 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Jay R. Smith Mfg. Co.
   2. Zurn Plumbing Products Group
   3. Watts

B. Water-Closet Supports:
   1. Description: Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Urinal Supports:
   1. Description: Urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
   2. Accessible-Fixture Support: Include rectangular steel uprights.

D. Lavatory Supports:
   1. Description: Type lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
   2. Accessible-Fixture Support: Include rectangular steel uprights.

2.6 WATER CLOSETS

A. Water Closets:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard
      b. Kohler
   2. Description: Accessible, Floor or wall-mounting, back-outlet or wall outlet, vitreous-china fixture designed for operation.
   3. Style:
      a. Design Consumption: 1.6 gal./flush .
      b. Bowl type: Elongated, include bolt caps matching fixture.
      c. Color: White.

2.7 URINALS

A. Urinals:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.
      b. Kohler
   2. Description: Accessible, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
      a. Design Consumption: .125 gal./flush
      b. Color: White.

2.8 LAVATORIES

A. Lavatories:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.
      b. Kohler Co.
   2. Description: Accessible, wall-mounting, vitreous-china fixture.

2.9 DRINKING FOUNTAINS/WATER COOLER BOTTLE FILLERS

A. Drinking Fountains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elkay Manufacturing Co.
   b. Haws Corporation.
2. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler with integral bottle filler for barrier free mounting height.
   a. Cabinet: Bilevel with two attached cabinets, all stainless steel.
   b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
   c. Control: Push bar.
   d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
   e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
   f. Drain(s): Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.1.
   g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
   h. Capacity: 8 gph (0.0084 L/s) of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
      1) Electrical Characteristics: 370 Watt; 120-V ac; single phase; 60 Hz.
   i. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.
   j. Need Shroud on higher unit to lower bottom edge- cane detection per ADA.
3. Accessible, wall-mounting drinking fountain.

2.10 SHOWER VALVES

A. Faucets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Leonard
   b. Symmons
   c. Acorn
2. Description: Accessible, wall-mounting shower valve, with and without slide bars. Shower head shall have a maximum flow rate of 1.5 GPM.

2.11 SINKS

A. Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard
   b. Elkay Manufacturing Co.
   c. Just Manufacturing Company.
2. Description: One or Two-bowl, commercial, counter-mounting, stainless-steel sink.

2.12 SERVICE SINKS

A. Service Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Kohler Co.
   c. Acorn Engineering Company
   d. Stern Williams
2. Description: Trap-standard- and floor-mounting, enameled, cast-iron fixture with roll-rim with back and rim guard on front and sides.

2.13 DISHWASHER AIR-GAP FITTINGS

A. Dishwasher Air-Gap Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Brass Craft Mfg. Co.; a Subsidiary of Masco Corporation.
      b. Dearborn Brass; a div. of Moen, Inc.
      c. Watts Brass & Tubular; a division of Watts Regulator Co.
   2. Description: Fitting suitable for use with domestic dishwashers and for deck mounting; with plastic body, chrome-plated brass cover; and capacity of at least 5 gpm; and inlet pressure of at least 5 psig at a temperature of at least 140 deg F (60 deg C). Include 5/8-inch ID inlet and 7/8-inch ID outlet hose connections.
   3. Hoses: Rubber and suitable for temperature of at least 140 deg F.
      a. Inlet Hose: 5/8-inch ID and 48 inches long.
   4. Outlet Hose: 7/8-inch ID and 48 inches long

PART - 3 EXECUTION

3.1 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
E. Install wall-mounting fixtures with tubular waste piping attached to supports.
F. Install fixtures level and plumb according to roughing-in drawings.
G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
J. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
K. Install toilet seats on water closets.
L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
M. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
N. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
O. Install traps on all fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
P. Install escutcheons at piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22.
Q. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Section 07 92 00 "Joint Sealants."

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
C. Ground equipment according to Section 26 05 26 "Grounding and Bonding."
D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.4 PROTECTION

A. Provide protective covering for installed fixtures and fittings.
B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 40 00

DIVISION 23 – HEATING, VENTILATING & AIR CONDITIONING

DIVISION 24 through DIVISION 25 – not used

SECTION 23 00 00 - HVAC GENERAL PROVISIONS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. Refer to BIDDING REQUIREMENTS, CONDITIONS OF THE CONTRACT, SUPPLEMENTARY CONDITIONS and DIVISION 1 of these specifications which govern work under DIVISION 23. Refer to other sections of these specifications for additional related requirements.

B. Codes, Permits and Fees:

1. Mechanical work shall be in accordance with the most recent adopted publication of the following:
   a. International Building Code
   b. International Mechanical Code
   c. Uniform Plumbing Code
   d. International Fire Code
   e. National Electric Code
   f. American Disability Act
   g. Washington State Energy Code
   h. All applicable State and Local Codes and Ordinances.
2. The Contractor shall obtain permits and inspections required for the mechanical work on this project at his expense. Deliver all inspection certificates to the Owner's Representative prior to final acceptance of the work.
3. Contractor(s) shall pay all costs levied by utility companies and/or governing agencies associated with water, gas, sanitary and storm sewer connections and include these costs within his bid. This shall include but not be limited to tap fees, service mains, meters and vault charges.

1.2 DESCRIPTION OF WORK

A. The work covered by the contract documents (specifications and construction drawings), shall include but not be limited to:

1. Furnishing all materials and supplying all labor, equipment and services to install the complete mechanical system as shown on the contract documents and specified herein.
2. All products and materials installed on the project shall be new and in first class condition. Used or resold materials will not be allowed. If requested to verify authenticity of materials the Contractor shall be prepared to produce bill-of-sale invoices.

B. This project has been designed to meet or exceed the minimum requirements of the governing Codes. The Contractor must notify the Owner's Representative in writing of any items in conflict with the Codes prior to signing the contract, or he shall thereafter make any minor adjustments necessary to meet the Codes at no cost to the Owner.

C. The Contractor shall comply with the project close-out requirements as detailed in Division 01, "Closeout Procedures."

D. Safety Measures:

1. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement applies continuously and is not limited to normal working hours.
2. Provide all required safety measures and consult with the State or Federal safety inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist.
3. Head protection: Where pipe hangers, equipment support angles, etc., are exposed in access ways for any maintenance, cover all such potentially injurious protrusions less than 7'-0" above the floor with padding; secure and permanently fasten, and finish to match adjacent finishes.

1.3 REFERENCES

A. Definitions

1. 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.
2. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
4. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
5. 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.

1.4 QUALITY ASSURANCE

A. Materials used under this Contract, unless specifically noted otherwise, shall be new and of the latest and most current model line produced by the manufacturer. Each item of equipment shall conform to the latest Standard Specifications of the American Society for Testing Materials and shall conform to any applicable standards of the United States Department of Commerce.

B. Electrically Driven or Connected Mechanical Equipment:
1. All electrically driven or connected equipment and associated control panels shall be provided with UL or equivalent label and/or listing in accordance with the requirements of the NEC. Equipment shall be listed as an assembly where listing/labeling program is available for that type of equipment.
2. 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.
3. All HVAC equipment provided in Division 23 requiring compliance with NEC Article 440 “Air-Conditioning and Refrigerating Equipment” shall be listed for a minimum short-circuit current (AIC) rating of 10,000 Amperes RMS. This equipment shall be listed under UL 1995 for both circuit breakers and fuses as the upstream overcurrent protective device. The nameplate shall read “Maximum overcurrent protective device” not “Maximum Fuse” or “Maximum Circuit Breaker.
4. All Division 23 equipment other than that provided in 2 above shall be listed or rated for a minimum of 10,000 AIC at 240, 208 or 120 volts and 14,000 AIC at 480 or 277 volts unless a higher value is specifically indicated on the drawings or in the specific equipment specifications.

C. Fuel fired equipment shall be listed by a nationally recognized testing laboratory for use with the particular fuel type.

D. Pressure vessels and relief valves shall be furnished in accordance with applicable State Boiler and Unfired Pressure Vessel Laws.

E. AWS states that welding qualifications remain in effect indefinitely unless welding personnel have not welded for more than six months or there is a specific reason to question their ability.

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

1.5 COORDINATION

A. Consider architectural and structural drawings part of this work insofar as these drawings furnish information relating to design and construction of the building and shall take precedence over mechanical drawings if any dimensional discrepancies exist.

B. The Contractor shall refer to the architectural and structural details, plans, elevations, and other Contract Drawings and shall coordinate his work with that of the other trades to avoid interference.

C. Dimensions are approximate and are for estimating purposes only, unless noted otherwise.

D. The mechanical drawings are diagrammatic and show general locations of fixtures, equipment, and pipe. Drawings are not to be scaled. Field verify exact size, location, invert, and clearances of existing material and equipment, and advise the Owners Representative of any discrepancies between the field conditions and the Drawings prior to any installation. Contractor shall be

responsible for all costs associated with the removal or relocation of systems that have been installed without prior notification of the Owners Representative.

E. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.

F. Prior to installation of the new Division 23 systems, the Contractor shall coordinate the proposed installation with the Architectural and Structural requirements and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension and Tile systems), and provide reasonable maintenance access requirements. Changes required in work specified in Division 23 caused by neglect to do so shall be made at no cost to Owner.

G. The Contractor shall be responsible for installation of systems according to the Contract Documents. Anything not clear or in conflict will be explained by making application to Owner's Representative. Should conditions arise where certain changes would be advisable, secure approval from Owner's Representative for those changes before proceeding.

H. Furnish sleeves, inserts, supports, and equipment that are to be integrated into other Divisions of the Work to those involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne under Division 23.

I. Electrical Coordination
   1. The electrical characteristics of all mechanical equipment to be furnished on the project shall be cross-checked with the Electrical Drawings, prior to ordering equipment, to confirm correct power supply; horsepower, kW, amps, voltage and phase. Where proposed equipment characteristics do not agree with the Electrical Drawings, the engineer shall be contacted for direction before proceeding.
   2. Electrical connection sizes: coordinate with the Electrical Drawings for proper electrical lug size and quantity on large capacity devices such as chillers, electric heaters, etc. and determine if the connections will accept either copper or aluminum conductors. Make necessary adjustments to equipment connections to accommodate electrical power feeder sizes and types.
   3. Disconnect Switches: Where disconnect switches are furnished integral with the equipment, mounting height shall not exceed 7 ft. (to top) above floor or roof level, including allowance for bases on roof curbs.

1.6 SUBMITTALS

A. Mechanical Cost Breakdown:
   1. The Contractor shall furnish the Owner's Representative an itemized breakdown of the mechanical construction cost within 30 days of notice to proceed. This breakdown shall be utilized for pay applications.
   2. At a minimum, the cost breakdown shall be as follows:
      a. Mobilization
      b. Ductwork Material
      c. Ductwork Labor
      d. HVAC Equipment
      e. HVAC Equipment Labor
      f. HVAC Water Treatment
      g. Hydronic Piping
      h. Hydronic Equipment
      i. Hydronic Labor
      j. Temperature Control Material
      k. Temperature Control Labor
      l. Test and Balance
      m. Commissioning Assistance
      n. Closeout

B. Payment Requests:
   1. Refer to Division 01 for Payment Procedures.
   2. Payment requests for materials and equipment will not be reviewed or approved until shop drawings have been received and approved.

C. Submittal Log: Contractor shall prepare a master submittal log tracking spreadsheet for all Division 23 items, to be filled in, updated and furnished with each submittal package. Submittal log shall indicate specification section and sub-paragraph of each item included in the submittal, along with a general description of the item/equipment, manufacturer name, date submitted and a column for returned date, A/E review action (i.e. approved, approved as noted, revise and resubmit or rejected) and re-submittal action required (if any).

D. Submit Shop Drawings and Product Data per the requirements of Division 01 Section, "Submittal Procedures." See individual Division 23 specification sections for additional submittal requirements.

1. Electronic Submittal: Organize electronic files in a similar manner to hard copy binders, with electronic indexing (bookmarks) and/or portfolio format for ease of organizing and navigating for A/E review and comment purposes. Additionally, submittals shall contain original PDF files capable of the find command (crtl+F) for digital searching. Photocopies of submittals that do not allow for digital searching are not acceptable. SUBMITTALS NOT PROVIDED IN THIS FORMAT WILL BE REJECTED.

E. Shop Drawings: Refer to Section 013300 for specific information regarding the preparation, submittal and approval of Shop Drawings.

1. Shop drawings, catalog information and material schedules shall be submitted for approval on all materials and equipment prior to ordering. This applies to all specified material and equipment in Division 23.
2. Shop drawings shall be reviewed, approved and stamped by Contractor prior to submitting to Owner's Representative for approval. Submittals without such approval will be returned without review.
3. Allow for sufficient time for developing shop drawings, processing and review time so that the installation will not be delayed.
4. Indicate manufacturer, trade name and model number. HIGHLIGHT, ENCIRCLE OR OTHERWISE INDICATE ALL DEVIATIONS FROM THE SPECIFIED PRODUCTS OR BASIS-OR-DESIGN EQUIPMENT. Include copies of applicable brochure or catalogue materials. Indicate sizes, types, model numbers, ratings and capacities being proposed. Only those items being used on the project shall be included in the submittal.
5. Where choices of options and accessories are available or specified, provide written description of what is to be furnished. If necessary, list page numbers where submitted items are described.
6. Include dimensional data for roughing in and installation and technical data sufficient to confirm that equipment meets requirements of drawings and specifications.
7. Include wiring, piping and service connection data, motor sizes complete with voltage ratings and schedules. Upon approval, copies of these diagrams shall be forwarded to pertinent contractors.
8. Upon approval, copies of these diagrams shall be forwarded to pertinent contractors

F. Product Data: Refer to Section 013300 for specific information regarding preparation, collation, labeling and submittal of Product Data.

1. Clearly identify product data submittal with the project name. Submittals containing resubmitted data shall also include a "Re-submittal" label in bold letters on the cover.
2. Indicate manufacturer, trade name and model number. Include copies of applicable brochure or catalogue material. Indicate sizes, types, model numbers, ratings, capacities and options actually being proposed.
3. Include dimensional data for roughing in and installation, and technical data sufficient to confirm that equipment meets requirements of drawings and specifications.
4. Include wiring, piping and service connection data, motor sizes complete with voltage ratins and schedules.
5. Submit all materials specified in this Division in one pdf binder.
6. Re-submittals shall include all materials being re-submitted in one binder. Only completed re-submittal including all applicable specification sections will be reviewed.
7. Allow for sufficient time for A/E review time (10 business days) so that the installation will not be delayed.

G. If material or equipment is not as specified or submittal is not complete, it will be rejected. Only completed submittal including all applicable specification sections will be reviewed.

H. Review comments shall not relieve Contractor from responsibility for deviations from Contract Documents unless attention has been called to such deviations in writing at time of submission, nor shall they relieve this Contractor from responsibility for errors in items submitted.

1.7 CLOSEOUT SUBMITTALS

A. General: Submit documents to the Owner/Owners Representative for approval [prior to the building being turned over to the Owner] [within 90 days of the date of receipt of the Certificate of Occupancy].

B. Record Documents: Construction documents shall be updated to convey a record of the alterations to the original design. Such updates shall include updated mechanical, electrical and control drawings red-lined, or redrawn if specified, that show all changes to size, type and locations of components, equipment and assemblies.

C. Mechanical Operating and Maintenance (O&M) Manuals

1. Refer to Division 01 for additional Closeout Submittal and Operation and Maintenance Data requirements.
2. Contents for the Mechanical O&M Manual are to include the following:
   a. Title Page: Project Name, Project Number, building name, Architect, Mechanical Engineer, Electrical Engineer and General Contractor.
   b. Table of Contents: Complete listing of contents of this O&M Manual. Where multiple volumes are required, provide Master Table of Contents covering all Volumes and place in the front of each volume.
   c. Part 1: Listing of all Contractors, subcontractors and suppliers/vendors for all tiers. Information to include: names, addresses, phone numbers, fax numbers and area of work. Also include a copy of the emergency service information required in Division 1.
   d. Part 2: Copies of all signed general, mechanical and plumbing permits, and inspection reports.
   e. Part 3: Copies of all manufacturer's warranty and guarantee forms, and any specified special guarantees, fully executed.
   f. Part 4: Provide a separate sub divider for each applicable Section in Divisions 22 & 23. Tabs are to be identified by specification section title (i.e. Valves for HVAC Piping) and not just specification section number (i.e. Section 23 05 23). For every Section provide the following:
      1) Index listing materials and equipment used.
      2) List of suppliers with address, phone number and fax number.
      3) Catalog cuts, data sheets, engineering calculations, schedules, wiring diagrams and complete parts lists for all products and equipment incorporated into the Project. Literature shall be clearly marked to indicate each specific item. Include copies of approved submittal data as part of this information.
      4) Approved submittal drawings (Option to submit Product Data Submittals as separate Volume(s) if contents are large).
      5) Manufacturer's printed operating instructions for all equipment including:
         a) Initial startup procedures and break-in routine.
         b) Normal operating instructions.
         c) Regulation, control, stopping and shutdown.
         d) Troubleshooting and emergency instructions.
         e) Seasonal operating instructions.
      6) Cleaning, lubrication and preventative maintenance instructions.
      7) Disassembly, repair and reassembly instructions, including alignment and adjustment instructions.
      8) Sequence of operation for each system.
   g. Part 5: Valve schedule, including location, system and function for each scheduled valve.
   h. Part 6: Filter schedule, including equipment item, filter type and size for each filter used on the Project.
   i. Part 7: Controls system manufacturer and calibration information, including wiring diagrams, shop drawings, schematics, record documents, and control sequence

descriptions. Desired or field determined set-points shall be permanently recorded on control drawings at control devices or, for digital control systems, in system programming instructions.

j. Part 8: Equipment startup records, test records and certifications. Include certification and test results for the disinfection of domestic water piping, and testing of backflow prevention assemblies, pipe pressure testing, duct leak testing and hydronic water treatment flushing and cleaning witness sheets.

k. Part 9: Testing, Adjusting and Balancing Report.

l. Part 10: Final Commissioning Report (Option to submit as separate Volume(s) if contents are large).

m. Part 11: Spare parts and maintenance materials list. Provide summarized list of spare parts that are to be furnished to the Owner.

n. Part 12: Owner training sign-off sheets. Notebook sleeves with DVD;s of training.

1.8 MAINTENANCE MATERIAL SUBMITTALS:

A. Spare Parts: Provide the following spare parts and turn over to the Owner.

1. Spare Bearings (Qty: 1) – Belt Driven Motors (1 per unit size)
2. Spare Belts (Qty:2) – Belt Driven Motors (1 per unit size)
3. Spare Unitary DDC Controllers (1), Tu.U. small control valves (1), Damper Actuators (2)
4. Gaskets - 2
5. Filters (see filter specification)
6. Gauges: (1) temp, (1) pressure
7. Glycol and Water Treatment Chemicals: Quantity adequate for 3 refills of glycol feeder.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Refer to Division 01 for Product Storage and Handling Requirements".

B. Follow manufacturer's directions in delivery, storage, protection, and installation of equipment and materials.

C. Promptly notify Owner's Representative in writing of conflicts between requirements of Contract Documents and Manufacturer's directions and obtain written instructions from Owner's Representative before proceeding with work. Contractor shall bear expenses of correcting deficiencies of work that does not comply with manufacturer's directions or such written instructions from Owner's Representative.

D. Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or mechanical injury but have readily accessible for inspection. Store items subject to moisture damage in a dry, heated space.

E. Special Storage Requirements:

1. Equipment and products to be stored on the project site either outside or inside but unheated spaces shall be provided with shrink-wrapped coverings and shall be additionally provided with chemical desiccant packs to control any stray moisture that may enter the protective wrapping.
2. Ductwork shall be stored on pallets on grade. Ductwork and air handling equipment shall be kept dry. Air handling equipment that has been allowed to become wet may be rejected.

F. New Equipment and Ductwork Protection:

1. Protect equipment and materials in storage on site, during and after installation until final acceptance. Leave factory covers in place and take special precautions to prevent entry of foreign material into working parts of piping and duct systems.
2. Protect equipment with polyethylene covers and crates.
3. Operate, drain and flush bearings and refill with change of lubricant before final acceptance.
4. Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Provide extended nipples for lubrication.
5. During construction, provide temporary closures of metal or taped polyethylene at all openings in new ductwork to prevent construction dust from entering existing ductwork system.
6. RA Grille Filters: Prior to the completion of all dirt and dust producing activities, cover all return intake grilles and openings with temporary MERV 8 filter media. Replace filters at Substantial Completion.

G. Notify Owner of equipment delivery dates 24 hours in advance of delivery.
H. The Contractor shall be responsible for protection of equipment furnished in this Division from vandalism and weather during all phases of construction. Damaged equipment shall be restored to like new condition or replaced at the Contractor's expense.
I. Any factory painted equipment scratched or marred during shipment or construction shall be restored to original "new" condition. This includes complete repainting if necessary to provide exact paint match.

1.10 FIELD CONDITIONS

A. Existing Utilities and Piping:
1. The locations of existing concealed lines and connection points have been indicated as closely as possible from available information. The Contractor shall assume that such connection points are within a Ten foot (10') radius of the indicated location. Where connection points are not within this radius, the Contractor shall contact the Owner's Representative for a decision before proceeding or may proceed at his own expense.
2. Connection points to existing work shall be located and verified prior to starting new work.
3. Prior to commencing any excavation or ditching activity, the Contractor shall verify the exact location and inverts of all existing utilities and connection points in the area of his proposed excavation. Notify Owner's representative for further direction if actual inverts will not allow the proper installation of new work.
4. The Contractor shall be responsible for damages, which might be caused by his failure to exactly locate and preserve underground utilities.

B. Existing Hazardous Materials: Refer to Division 00 for information, instructions, and requirements regarding existing potentially hazardous materials including, but no limited to, asbestos and lead.
1. Specific attention is directed to the potential existence of asbestos bearing compounds and materials on remodel and demolition projects. Careful coordination with other Contractors and reasonable care shall be exercised.
a. Extent of Asbestos:
1) It can be assumed that the Owner will have removed all asbestos from the construction area of this project prior to this contract.
2) An asbestos survey of the building has been performed and reports the extent of asbestos located throughout the building.
3) A copy of the Asbestos Survey is located in the project manual.
b. If asbestos bearing or other hazardous compounds are encountered during the course of construction that are not identified in the Asbestos Survey, the Contractor shall immediately notify the Owners Representative.

1.11 WARRANTY

A. The Mechanical equipment and installation shall be warranted for a period of one (1) year from the date of acceptance unless an individual item or specification is otherwise noted as longer. The Contractor shall make good, at his own expense, all defects in work and/or furnished equipment which develop at any time during the warranty period and shall bare all expenses including that of cutting and patching.
B. Refer to individual Division 23 specification sections for warranties required to extend beyond the 1-year project warranty period.

1.12 TEMPORARY HEATING, COOLING OR VENTILATION

A. Temporary heating, cooling or ventilation for the facility during the construction phase shall not be supplied by the permanent system installed under Division 23.
B. Exceptions:
1. Contractor shall obtain letter of approval from the Owner stating that they understand equipment expected life may be shortened due to severe usage.
2. Product warranties shall be extended to account for construction use. Contractor shall furnish certified document stating such extended warranties.
3. Contractor shall be responsible for pressure cleaning all coils and vacuum cleaning all ductwork prior to occupancy.

4. If Contractor is given permission to use permanent systems for space heating, cooling or ventilation filters shall be installed equal to Farr 30/30. Check and change filters at intervals sufficient to protect the mechanical system. Units shall not be operated without filters in place. New filters shall be installed prior to system balancing.
5. Prior to the completion of all dirt and dust producing activities, cover all return intake grilles and openings with temporary filter media. Replace filters at Substantial Completion.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Refer to Division 01 Substitution Procedures regarding product prior approval and substitution requirements.
B. Throughout these specifications and drawings, various materials, equipment, apparatus, etc., are specified or scheduled by manufacturer, brand name, type or catalog number. Such designation is to establish standards of desired quality and construction and shall be the basis of design and the bid.
C. Substitutions will not be permitted without written approval.
D. Where two or more manufacturer designations are listed in these specifications, choice will be Contractors option.
   1. Exception: Where more than one manufacturer is listed, and only one manufacturer's catalog number is specified or only one manufacturer is scheduled on the drawings (basis of design), that standard of quality, dimensional characteristics, capacities, and construction shall be maintained by materials or equipment supplied by the other manufacturer(s).
E. If the Contractor uses manufacturers other than the basis of design, the Contractor shall be responsible for:
   1. Ensuring the substituted item will perform identical to the basis-of-design equipment, fit in the available space while allowing proper maintenance access. In the event other than specified equipment is used and will not fit job site conditions, the Contractor assumes responsibility for replacement with items indicated as the basis of design.
   2. Any changes required by other Contractors caused by the substituted equipment, such as different electrical characteristics, control point requirements, etc.
   3. Changes in structural design and/or construction due to weight differences.
F. Products furnished other than the basis of design shall have similar electrical characteristics as the scheduled or specified equipment. Contractor shall be responsible for any electrical changes caused by products not in accordance with this requirement.

2.2 ELECTRICAL MOTORS

A. All electrical motors furnished on the project, whether provided with factory packaged equipment such as pumps, fans, air handlers, fan coil units, etc., or provided separately for field mounting, shall meet or exceed the minimum energy efficiency requirements of Washington State Energy Code, 2012 - Table 10.8, or ASHRAE 90.1 - 2010, Tables 10.8A/B/C, whichever is more stringent.
B. Motors used with Variable Frequency Drives (VFDs): Motors shall be Premium efficiency type NEMA MG 1 Part 31 compliant, Class F insulation, rated as "Inverter Duty".
C. ECM (Electrically Commutated Motor) type single-phase motors utilized on direct drive applications, shall be ultra-high efficiency type with programmable brushless DC motor, utilizing a permanent magnet rotor and built-in inverter. Permanently lubricated ball bearing design. Provide with integral microprocessor controller for variable speed control (constant torque or external input variable speed control) as indicated.

2.3 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.
C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop, unless otherwise noted.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.
E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
F. PVC Pipe: ASTM D1785, Schedule 40.
G. Molded PE: Reusable, PE, tapered-cup shaped and smooth-outer surface with nailing flange for attaching to wooden forms.

2.4 MECHANICAL SLEEVE SEALS

A. Acceptable Products: Subject to compliance with requirements, provide the following products or approved equal:
   1. Link seal by GPT Industries.
B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
C. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe and fiberglass duct. Include type and number required for pipe material and size of pipe.
D. Pressure Plates: Stainless steel. Include two for each sealing element.
E. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.
D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

2.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 8 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi compressive-strength concrete and reinforcement as specified in Division 03.

2.7 GROUT

A. Description: ASTM C1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.8 ACCESS DOORS

A. Access doors to match surrounding surface, provided with recess to accept matching finish in accordance with the requirements of Division 08. Provide UL rated doors in fire rated construction.

B. Provide flush type steel framed panel with concealed hinges, size minimum 24 x 25 inch for man access and minimum 18 x 18 inch for inspection and hand access.
C. Provide cam type locking device with hand or key lock when located in public corridors and washrooms complete with master keys.
D. Provide access doors for maintenance or adjustments purposes for all mechanical system components including valves, volume dampers, fire dampers, fire/smoke dampers, clean outs, traps and controls.

2.9 ROOF CURBS

A. Roof curb construction for mechanical equipment shall be carefully coordinated with the architectural and structural roof systems for compatibility, including proper pitch to create a level mounting surface, adequate curb height to allow for roof insulation thickness (including taper and roof crickets at curbs), and flashing details.
B. Roof curb sidewall heights shall be a minimum of 12" above the surrounding roof insulation thickness or as noted on the plans. Allow for tapered insulation and cricket thickness when determining curb height.
C. Roof curb base construction shall be compatible with roof construction (metal decks, concrete decks, etc.) and mounting and anchoring shall be coordinated with the structural systems present.
D. Roof curbs shall be constructed and installed air tight as they are part of the building envelope.
E. Roof curbs mounted on metal decks shall be in-filled (below the unit/platform) with a minimum of two (2) layers of 5/8" gyp board (for sound dampening) and at least 4" thickness of roofing insulation boards.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine premises and understand the conditions which may affect the execution of work of this Division before submitting proposals for this work.
B. No allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

3.2 INTERFACE WITH OTHER WORK – COORDINATION

A. It is understood that anything not clear or in conflict will be explained by making application to Owner's Representative. Should conditions arise where certain changes would be advisable, secure approval from Owner's Representative for those changes before proceeding with work.
B. Coordinate with the work of various trades when installing interrelated work. Before installation of mechanical items, make proper provision to avoid interference's. Changes required in work specified in Division 23 caused by neglect to do so shall be made at no cost to Owner.
C. Furnish and install inserts and supports required by Division 23 unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to those involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne under Division 23.

3.3 INSTALLATION

A. Coordinate Division 23 equipment and systems to the available space, with other trades. The access routes through the construction shall be the Contractor's responsibility.
B. Drawings are diagrammatic. Make offsets, transitions, and changes in direction of pipes and ducts, as required to maintain proper headroom and pitch of sloping lines and avoid structural, electrical, pipe and duct interference's whether or not indicated on Drawings. Furnish fittings, etc., as required to make these offsets, transitions and changes in direction at no additional cost to the Owner.
C. Determine exact route and location of each pipe and duct and coordinate and obtain approval for changes from the layout indicated on the drawings with the Owner's Representative prior to fabrication.

D. Locations of equipment and devices, as shown on the drawings, are approximate unless dimensioned. Verify the physical dimensions of each item of mechanical equipment to fit the available space and promptly notify the Owner's Representative prior to roughing-in if conflicts appear.

E. All piping, wiring, equipment, ductwork, tubing, etc., shall be concealed within building construction unless otherwise noted, or in mechanical rooms.

F. Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, trap primers, starters, motors, control components, and to clear openings of doors and access panels.

G. Prior to installation of the new Division 23 systems, the Contractor shall coordinate the proposed installation with the Architectural and Structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension and Tile systems), and provide reasonable maintenance access requirements.

H. Provide means of access to all valves, dampers, controllers, operable devices and other apparatus which may require adjustment or servicing.

I. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Owners Representative of any discrepancies between that indicated on the Drawings and that existing in the field prior to any installation. Contractor shall be responsible for all costs associated with the removal or relocation of installed systems that have been installed without prior notification of the Owners Representative.

J. Equipment Installation – Common Requirements:
   1. Install equipment in accordance with the manufacturer's instructions. Where the construction documents appear to conflict with the manufacturer's instructions, contact the A/E for direction before proceeding with installation. Rework caused as a result of failing to resolve conflicting information beforehand shall be done at no additional cost to the Owner.
   2. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
   3. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
   4. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting with minimum interference to other installations. Extend grease fittings to accessible locations.
   5. Install equipment to allow for piping to be installed at required slope.
   6. Motor and equipment name plates as well as applicable UL and AGA labels shall be in place when the Project is turned over to the Owner.

K. Erection of Metal Supports and Anchorages:
   1. Refer to Division 05 Section "Metal Fabrications" for structural steel fabrication requirements.
   2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
   3. Field Welding: Comply with AWS D1.1.

L. Grouting:
   1. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
   2. Clean surfaces that will come into contact with grout.
   3. Provide forms as required for placement of grout.
   4. Avoid air entrapment during placement of grout.
   5. Place grout, completely filling equipment bases.
   6. Place grout on concrete bases and provide smooth bearing surface for equipment.
   7. Place grout around anchors.
   8. Cure placed grout.

M. Access Openings for Valves, Dampers, Etc.
   1. Provide access doors wherever required to service valves, dampers, fire dampers, motors or any other concealed items requiring access, unless specifically indicated on the drawings to be furnished under other Divisions (i.e., architectural). Access doors for fire dampers shall be installed in duct adjacent to fire damper. Equipment which is accessible by means of removable ceiling panels or tile does not require access doors or panels.

Access doors and panels for service and maintenance of items shall be sized and located to allow adequate access for required service.

N. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 for penetration fire-stopping for materials.

O. Switchgear/Electrical Equipment Drip Protection:
   1. Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum amount of joints.
   2. Installation of piping, ductwork, leak protection apparatus or other installations foreign to the electrical installation shall be located in the space equal to the width and depth of the equipment and extending to a height of 1.8 m (6 ft.) above the equipment to ceiling structure, whichever is lower (NFPA 70).

P. Inaccessible Equipment:
   1. Where the A/E determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.
   2. The term “conveniently accessible” is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

Q. Cutting and Patching:
   1. Perform all cutting and patching of new and existing construction required for the installation of systems and equipment specified in Division 23. All cutting shall be accomplished with masonry saws, drills or similar equipment to provide neat uniform openings. Field verify locations for new openings to avoid conflict with new or existing structure, architectural elements or other utilities. Coordinate penetration locations.
   2. Patch and repair walls, floors, ceilings and roof with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials. All patching shall meet the approval of the Owner’s Representative. Where existing mechanical systems are removed and roof or wall openings are not to be reused for new systems, the Division 23 Contractor shall be responsible for in-filling the abandoned opening per above.
   3. All cutting and patching made necessary by defective equipment, defective workmanship or failure of this Contractor to properly anticipate his requirements shall be included.
   4. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses or other structural members without the Owner Representative’s written approval.
   5. Cutting, patching, repairing, and replacing pavement, sidewalks, roads, and curbs to permit installation of work specified or indicated under this Division is included.

R. Demolition and Salvage:
   1. Refer to Division 01 for cutting, patching, waste management and disposal, recycling, reuse and documentation requirements.
   2. Comply with all Local, State and EPA requirements for glycol antifreeze and/or refrigerant disposal and/or reclaim.
      a. Where existing refrigeration systems are disturbed by the demolition or new work, the existing refrigerant gas charge shall not be vented to the atmosphere but shall be captured and reclaimed/reused (if in good condition) or disposed of in a safe and legal manner.
      b. Where existing glycol anti-freeze hydronic systems are impacted by the work, the existing anti-freeze glycol-water solutions shall be either captured and stored for reuse, or disposed of in a safe and legal manner. Refill systems with same level of glycol protection as original (or as specified new).
   3. Demolition of mechanical systems and equipment in remodeled areas shall be provided under Division 23.
   4. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

a. Ducts to be removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
b. Equipment to be removed: Disconnect and cap services and remove equipment.
c. Equipment to be removed and reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
d. Equipment to be removed and salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

5. 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.
6. Where the plans are not clear on what existing systems are to remain and be reused or retained for later upgrades, the Contractor shall contact the Owner's Representative for direction before proceeding with demolition work.
7. Systems, materials and equipment designated for demolition, shall be salvaged to the Contractor and removed from the site unless otherwise noted.
8. Equipment and materials salvaged to the Owner shall be delivered to an owner approved on-site location.
9. Contractor shall repair any existing equipment damaged as a result of his work.
10. Verify and document condition of existing systems to be connected to prior to construction.
    a. Submit to A/E a list of required equipment repairs due to existing conditions.
    b. Required repairs not documented will be made by the Contractor at his own expense.
11. Contractor's bid shall include re-claim and disposal of refrigerant from existing systems indicated to be removed.

3.4 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Division 01 - General Commissioning Requirements. The Contractor has specific requirements for scheduling, coordination, startup, test development, testing and documentation efforts and will need to allocate manpower and resources accordingly.
B. Coordinate all commissioning activities with the Commissioning Authority.

3.5 EQUIPMENT TESTING

A. Equipment Tests: Equipment shall be subject to tests as specified in individual Division 23 specification sections.
B. Demonstrate that the mechanical equipment and systems are performing to provide conditions through all possible modes of operation as outlined below. The verification testing procedures shall address all operating characteristics of all mechanical equipment and systems. Equipment and systems shall be tested in accordance with the manufacturer's requirements and the Commissioning testing requirements.
C. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Owner's Representative in writing, or as witnessed by the Commissioning Authority, that the specified tests have been performed and that the installation complies with the specified requirements.
    1. Provide equipment start-up test reports on forms provided by the manufacturers, filled-in, dated and signed by the authorized start-up agent or technician. Include copies of start-up reports in the O&M manuals.
D. A record similar to the following shall be kept to record each test and copies shall be sent to the Owner's Representative after each test is complete:

EQUIPMENT TESTS:

SYSTEM TESTED	TESTED BY (CO. or MFR)	TESTING AGENT (Name)	DATE
Chillers			
Boilers			

Split System AC Units			
Air Handling Units			
Pumps			
Exhaust Fans/Systems			
Fan Coil Units			
Water Treatment			
Unit Heaters			
HVAC Controls			

3.6 PIPING AND DUCTWORK TESTING

A. Piping and duct systems shall be subject to tests as specified in the applicable Division 23 sections.

B. No piping shall be covered, insulated or concealed until it has been tested, inspected and approved by any local authority having jurisdiction. Isolate systems during testing and flushing.

C. Ductwork systems and specialties shall be subject to testing as specified in the applicable Division 23 sections.

D. Tests and repairs shall be completed prior to concealment or insulation of ducts.

E. Provide all test equipment including test pumps, gauges, instruments and other equipment required. Test all rotating equipment for proper direction of rotation. Upon completion of tests contractor shall certify in writing to the Owner's Representative, or as witnessed by the Commissioning Authority, that the specified tests have been performed and that the installation complies with specifications.

1. Provide pipe and duct pressure and leakage reports on forms developed by the contractor or based on SMACNA, filled-in, dated and signed by the authorized start-up agent or technician. Include copies of start-up reports in the O&M manuals

F. A record similar to the following shall be kept to record each test and copies shall be sent to the Owner's Representative after each test is complete:

PIPING & DUCT SYSTEM TESTS:

SYSTEM TESTED	TESTED BY (CO. or MFR)	TESTING AGENT (Name)	DATE
Heating Hot Water Piping			
Chilled Water Piping			
Medium Velocity Duct System			
Refrigeration Piping			

3.7 96 HOUR TEST RUN & BUILDING FLUSH-OUT

A. Refer to Section INSTRUMENTATION AND CONTROLS FOR HVAC for 96 hour test run requirements and building IAQ flush-out requirements.

B. Provide adequate time in the project schedule for these functions, which may be done in conjunction with certain Commissioning and Owner training activities.

3.8 CLOSEOUT ACTIVITIES

A. Demonstration and Owner Training: Instruct the designated Owners representative(s) in operation and maintenance of mechanical systems utilizing the information and material available in the Operation and Maintenance Manual.

1. Upon completion of the equipment and systems installation and connections, start-up, testing and balancing, and at the end of each Construction Phase, the Contractor shall assemble all major equipment factory representatives and subcontractors together for the Owner instructional period.

a. Coordinate training schedule in advance with Owner's representative so that the required Owner personnel may be present and also to minimize the number of sessions required and/or return trips by factory agents.

b. Coordinate training periods with Commissioning requirements.

2. Instruction period shall occur after start-up and testing activities have occurred, the controls are operational and when systems are properly working. Training may occur before Commissioning is finalized.
3. All training sessions shall be recorded on Video.
   a. Furnish DVD or flash drive copy of training videos with O&M Manual.
   b. Organize each individual training session as a separate file or folder for quick and easy searching by subject.
4. Instructional sessions for each system or equipment shall be led by the authorized factory agent, technician or system installer. Provide an overview of the system or equipment's function and operation as well as a detailed instructional description on all required maintenance and service requirements. Training periods shall allow the Owner's personnel to operate and/or inspect equipment until they fully understand the process and acknowledge such to the trainer.
5. Prepare statement and check list, similar to below, to be included in the Operation and Maintenance Manual. This Statement shall read as follows:

   OWNER TRAINING SIGN-OFF:

   "The Contractor, associated factory representatives and subcontractors have started each system and the total system and have proved their normal operation to the Owner's representative and have provided instruction on the operation and maintenance thereof."

   DATE: _____

SYSTEM OR EQUIPMENT	TRAINED BY (CO. & NAME)	OWNER'S STAFF (NAMES & SIGNATURES)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

6. Copies of this acceptance sign-off sheet shall be sent to the Owner's Representative and included in the O & M manual.

B. Owner Acceptance, Hand-off, Operational & Maintenance Responsibilities & Warranty:
1. Refer to the General Conditions and Division 01 for the definitions or and additional requirements associated with "Prior Occupancy", "Substantial Completion", "Correction on Nonconforming Work", "Final Completion" and "Warranty of Construction", and other project close-out, substantial completion and warranty requirements.
2. Near the end of the project, or at the end of each phase, schedule a meeting with the Owner, A/E, Commissioning Authority and select major subcontractors, including the Temperature Control Contractor, to discuss mechanical system turn-over responsibilities and expectations. Agenda shall include the following topics:
   a. Status of system completion, testing and Owner training.
   b. Commissioning status and outstanding issues.
   c. Status of control system operation and outstanding issues.
   d. Date(s) of Owner occupancy and beneficial usage.
   e. Date(s) of Substantial Completion and warranty start & end. Include end dates for extended equipment warranties and special conditions.

f. Owner and Contractor responsibilities during close-out and warranty period, including an understanding of which party is responsible for the following items:
    1) Filter maintenance & replacement.
    2) Equipment lubrication & regular maintenance.
    3) Control system & alarm monitoring, adjusting and trouble-shooting.
    4) Water treatment chemical and glycol maintenance.
    5) Equipment problems, diagnosis and trouble-shooting.
    6) Warranty call-backs vs. normal system behavior and fine-tuning.
    7) Outstanding work, Commissioning issues and follow-up.

g. Provide & distribute copies of the Hand-off meeting minutes to all parties involved.

3. Notwithstanding other requirements in the General Conditions and Division 01, once the Owner has taken beneficial occupancy and the mechanical systems have been made operational, tested, commissioned and the Owner has received training, it is expected that the Owner will be responsible for ongoing system operations, maintenance and control activities, except as otherwise determined above during the Hand-off meeting.
4. Once the Owner has taken over primary responsibility for the operation and maintenance of the mechanical systems, the Contractor shall still be obligated to complete all outstanding work in accordance with the Contract Documents, including, but not limited to those items as identified in the Commissioning issues logs, punch lists, or other reports, as well as correct all nonconforming work and repair all defective work as identified during the warranty period.

C. Punch List Procedures:
1. Refer to Division 01 Closeout Procedures for general punch list procedures.
2. The project shall be fully cleaned and in all respects ready to turn over to the Owner for occupancy before the Punch List Inspection is requested. This shall include but not be limited to:
    a. Cleaning up all equipment, materials, cartons, and other debris that is a direct result of the installation of equipment under this contract.
    b. Cleaning exposed piping, ductwork, equipment, and fixtures.
    c. Repairing damaged finishes.
3. The Contractor shall notify the Owner's Representative in writing when the project or phase is ready for punch lists. After punch lists are complete, written notice must be forwarded to the Owner's Representative requesting final checkout.
4. At the time of final observation, the contractor shall accompany the observation party and shall remove access panels as required, to allow complete observation of the entire mechanical system.

END OF SECTION 23 00 00

SECTION 23 05 19 - METERS AND GAGES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following meters and gages for mechanical systems:
   1. Thermometers.
   2. Gages.
   3. Test plugs.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.
B. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 THERMOMETERS

A. Liquid-in-Glass Thermometers:
   1. Manufacturers:
      a. Ernst Gage Co.
      b. Eugene Ernst Products Co.
      c. Marsh Bellofram.
      d. Miljoco Corp.
      e. Trerice, H. O. Co.
      f. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
      g. Winters Instruments.
   2. Case: Plastic, 7 inches long.
   3. Tube: Red or blue reading, mercury or organic-liquid filled, with magnifying lens.
   4. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
   5. Window: Glass or plastic.
   6. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
   7. Stem: Metal, for thermowell installation and of length to suit installation.
   8. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

B. Bimetallic-Actuated Dial Thermometers:
   1. Manufacturers:
      a. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
      b. Ernst Gage Co.
      c. Eugene Ernst Products Co.
      d. Marsh Bellofram.
      e. Miljoco Corp.
      f. NANMAC Corporation.
      g. Noshok, Inc.
      h. Palmer - Wahl Instruments Inc.
      i. REO TEMP Instrument Corporation.
      j. Tel-Tru Manufacturing Company.
      k. Trerice, H. O. Co.
      l. Weiss Instruments, Inc.
      m. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
      n. WIKA Instrument Corporation.
      o. Winters Instruments.

2. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.
3. Case: Dry type, stainless steel with 3-inch diameter.
4. Element: Bimetal coil.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red metal.
7. Window: Glass or plastic.
8. Ring: Stainless steel.
9. Connector: Adjustable angle type.
10. Stem: Metal, for thermowell installation and of length to suit installation.
11. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

C. Thermowells:
1. Manufacturers: Same as manufacturer of thermometer being used.
2. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.2 PRESSURE GAGES

A. Manufacturers:
1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Eugene Ernst Products Co.
5. KOBOLD Instruments, Inc.
6. Marsh Bellofram.
7. Miljoco Corp.
8. Noshok, Inc.
9. Palmer - Wahl Instruments Inc.
10. REO TEMP Instrument Corporation.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red metal.
7. Window: Glass.
8. Ring: Metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:
1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.3 TEST PLUGS

A. Manufacturers:

1. Flow Design, Inc.
2. MG Piping Products Co.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Co.
6. Trerice, H. O. Co.
7. Watts Industries, Inc.; Water Products Div.

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

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

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

E. Test Kit: Furnish one test kit containing one pressure gage and adaptor, one thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
4. Carrying case shall have formed instrument padding.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install thermometers in the following locations:
1. Inlet and outlet of each hydronic coil in air-handling units.
2. As indicated on piping diagrams shown on construction drawings.

B. Provide the following temperature ranges for thermometers:
1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
2. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

A. Install pressure gauges on each side of the steam reducing station.

B. Install pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

C. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.

D. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.

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

F. Install remote-mounting pressure gages on panel.

G. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).

H. Install test plugs in tees in piping.

I. Install flow indicators, in accessible positions for easy viewing, in piping systems.

J. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.

K. Install flowmeter elements in accessible positions in piping systems.
L. Install permanent indicators on walls or brackets in accessible and readable positions.
M. Install connection fittings for attachment to portable indicators in accessible locations.
N. Install gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.
O. Adjust faces of meters and gages to proper angle for best visibility.
P. Install P/T port at each DDC temperature and pressure sensor.

3.4 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 05 19

SECTION 23 05 23 - VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following general-duty valves:
   1. Hydronic Valves.
   2. Hydronic Balancing Valves.
   3. Venturi.

B. See Division 23 Section "HVAC Instrumentation and Controls" for control valves and actuators.

C. See Division 23 piping Sections for specialty valves applicable to those Sections only.

1.2 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; furnished specialties; and accessories.

1.3 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.
   1. Exceptions: Domestic hot- and cold-water, piping valves unless referenced.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

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

PART 2 - PRODUCTS

2.1 VALVES: GENERAL

A. Valve ratings shall exceed respective system operating pressures by 50% (minimum). All valves shall be line size except where specifically noted otherwise.

B. Product Data: Submit manufacturer’s technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing manufacturer’s figure number, size location, and valve features for each required valve.

C. Shop Drawings: Submit manufacturer’s assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

D. Where clearance does not allow the use of rising stem valves as specified, provide a non-rising stem valve of equal quality.

E. Acceptable Manufacturers (manufacturer and model number listed for individual valves indicates minimum acceptable by all manufacturers):
   1. Ball, Check, Plug or Butterfly: Nibco, Crane Hammond, Grinnell Milwaukee, Muellar, Stockham, Victaulic, Red White Valves.
   2. Relief Valves: Armstrong, B&G, Acme.
   3. Backflow Preventers: Febco.
   4. Pressure Reducing Valves: Febco.
   5. Thermostatic Mixing Valves: Leonard or Powers.
   6. Balancing Valves: Red White Valves, B&G, Armstrong, Griswold or Flowdesign.

F. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves, other than plug valves. Provide one wrench for every 10 plug valves, and one in each size. Provide extended levers/stems on valves on insulated lines.

G. Valve Features:

1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
2. Bypass: On valves 6” and larger comply with MSS SP-45, and except as otherwise indicated, provide manufacturer’s standard bypass piping and valving. Provide a 3-valve bypass, minimum 1” size, to consist of two threaded shut-off valves and a plugged drain valve.
3. Drain: Comply with MSS SP-45, and provide threaded pipe plugs.
4. Fanged: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).
5. Threaded: Valve ends complying with ANSI B2.1.
6. Solder Joint: Valve ends complying with ANSI B16.18.
7. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

2.2 HYDRONIC VALVES: MAXIMUM 125 PSIG SYSTEM WORKING PRESSURE

A. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 15 Section "Controls and Instrumentation."

B. Butterfly Valves:
1. 2-1/2” and Larger: MSS SP-67, lug type, ductile iron body, stainless steel disc, stainless steel stem, EPDM seat, memory stop control, lever handle thru 5” size and worm gear operator for 6” and larger. Mount stem in horizontal position. Lug style mounting.

C. Ball Valves:
1. 2” and Smaller: 400 psi, 3-piece brass body, stainless steel ball, teflon seat, brass stem, steel handle, conventional port. Threaded ends for copper pipe and iron pipe.

D. Check Valves:
1. 2” and Smaller: Class 125, MSS SP-80, ASTM B62 and ASTM B16, cast bronze body, threaded ends for copper pipe and iron pipe, screwed cap, swing type, Teflon bronze disc.
2. 2-1/2” and Larger: Class 125, MSS SP-71, ASTM A126 class B cast iron body, bolted bonnet flanged ends, bolted cap, swing type, cast iron disc with bronze face rings.
3. Silent Check 2-1/2” and Larger: Class 125, ASTM A126 class B cast iron body, flanged globe style, silent non-slam design, spring loaded, center guided, bronze trim, stainless steel spring and screws.

E. Drain Valves:
1. Threaded ends, Class 125, ASSE 1005, bronze body, screw-in bonnet, rising stem, composition disc, ¾” hose outlet.

F. Lubricated Plug Valve:
1. Class 125, Mss SP-78, 200 psi, U.L. listed, AGA approved for pressure of system, lubricated plug type, semi-steel body, wrench operated, straight way pattern round port, combination button head fitting and lubricant screw, teflon seal and discs.

G. Pressure Relief Valves:
1. Pressure Relief Valves: Constructed in accordance with ASME, 125-pound setting, and so stamped. Size as required.
2. Temperature and Pressure Relief Valve: Constructed in accordance with ASME, 125-pound setting, and so stamped. Size as required Watts #100XL, 40XL, 140, N240, or 340 Series.

2.3 HYDRONIC BALANCING VALVES

A. Pressure Independent Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Flow Design, Inc.
b. FlowCon Intl.
c. Griswold Controls.
d. Nexus

e. Prior approved manufacturers: Red White Valves
2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 250 deg F.

B. Pressure Dependent, Bronze, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong Pumps, Inc.
b. Bell & Gossett Domestic Pump; a division of ITT Industries.
c. Flow Design Inc.
d. Taco.
e. FlowCon Intl.
f. Nexus
g. Prior approved manufacturers: Griswold Controls, Red White Valves
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.
7. Pressure Gage 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.

C. Pressure Dependent, Cast-Iron or Steel, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong Pumps, Inc.
b. Bell & Gossett Domestic Pump; a division of ITT Industries.
c. Flow Design Inc.
d. Taco.
e. FlowCon Intl.
f. Nexus
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Threaded.
8. Pressure Gage 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.

2.4 VENTURI WATERFLOW MEASURING DEVICE:
A. Accuracy: Plus/minus 1 percent at design flow.
B. Mazimum pressure drop: 0.8 FT.
C. Provide safety shut-off valves, sensing taps, nipples and quick connection couplings.
D. Identify with metal tag on chain indictating:
1. Size.
2. Location.

3. GPM.
4. Meter reading for GPM indicated.

E. Sizes ½ IN through 2 IN brass, screwed.
F. Sizes 2-½ IN and over steel, flanged or butt welded.
G. Prior approved manufacturers: Nexus, Griswold Controls

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Balancing valve type (pressure dependent vs. pressure independent).
   1. The Hydronic floor plans and details indicate locations of each type of balancing valves. The balancing valve types are not interchangeable, and shall be provided as indicated on the drawings.
   2. Generally pressure independent balancing valves shall be used on constant flow coil assemblies that utilize 3-way control valves. Pressure independent balancing valves shall be used on variable flow coil assemblies that utilize 2-way control valves, as a way to initially proportion flow during full system flow test and balancing procedures.
C. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
D. Locate valves for easy access and provide separate support where necessary.
E. Install valves in horizontal piping with stem at or above center of pipe.
F. Install valves in position to allow full stem movement.
G. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
   3. Lift Check Valves: With stem upright and plumb.

3.2 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Basic HVACl Materials and Methods" for basic piping joint construction.
B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

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 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 05 23

SECTION 23 05 29 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY
- A. This Section includes the following:
  1. Steel pipe hangers and supports.
  2. Trapeze pipe hangers.
  3. Metal framing systems.
  4. Thermal-hanger shield inserts.
  5. Fastener systems.
  6. Equipment supports.
- B. See Division 5 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
- C. See Division 23 Section "Mechanical Seismic Controls" for seismic anchoring requirements.
- D. See Division 23 Section "Metal Ducts" and for duct hangers and supports.

1.2 DEFINITIONS
- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS
- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.4 SUBMITTALS
- A. Product Data: For the following:
  1. Steel pipe hangers and supports.
  2. Thermal-hanger shield inserts.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
  1. Trapeze pipe hangers. Include Product Data for components.
  2. Metal framing systems. Include Product Data for components.
  3. Equipment supports.
- C. Welding certificates.

1.5 QUALITY ASSURANCE
- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS
- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.
3. Globe Pipe Hanger Products, Inc.
4. Grinnell Corp.
5. National Pipe Hanger Corporation.
6. PHD Manufacturing, Inc.
7. PHS Industries, Inc.
8. Piping Technology & Products, Inc.
9. Tolco Inc.

C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.3 TRAPEZE PIPE HANGERS

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

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
B. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.
B. Manufacturers:
1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
a. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
a. Hilti, Inc.
b. ITW Ramset/Red Head.

c. Masterset Fastening Systems, Inc.
d. MKT Fastening, LLC.
e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
f. B-Line Systems, Inc.; a division of Cooper Industries.
g. Empire Industries, Inc.
h. Hilti, Inc.
i. ITW Ramset/Red Head.
j. MKT Fastening, LLC.
k. Powers Fasteners.

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

2.8 MISCELLANEOUS MATERIALS
A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
a. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS
A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
a. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 .
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 , requiring clamp flexibility and up to 4 inches of insulation.
4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
5. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
6. 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.
7. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
a. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

F. 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 20.
      a. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
      a. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   6. C-Clamps (MSS Type 23): For structural shapes.
   7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      a. Light (MSS Type 31): 750 lb.
      b. Medium (MSS Type 32): 1500 lb.
      c. Heavy (MSS Type 33): 3000 lb.
   8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
   9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

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

J. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
   3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

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

L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

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

3.2 HANGER AND SUPPORT INSTALLATION

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

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

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

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

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

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

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

H. 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.

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

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

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

L. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Hydronic Piping: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      b. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
   5. Pipes NPS 8 and Larger: Include wood inserts.
   6. Insert Material: Length at least as long as protective shield.
   7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 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 smooth bearing surface.
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 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 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.

3.6 PAINTING

A. Touch Up: 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 minimum dry film thickness of 2.0 mils.
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.7 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 05 29

SECTION 23 05 48 - MECHANICAL VIBRATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following vibration isolation for mechanical equipment:
   1. Elastomeric isolation pads and mounts.
   2. Restrained elastomeric isolation mounts.
   3. Freestanding and restrained spring isolators.
   4. Housed spring mounts.
   5. Elastomeric hangers.
   6. Spring hangers.
   7. Thrust limits.
   8. Pipe riser resilient supports.
   9. Resilient pipe guides.

B. For seismic controls for mechanical systems refer to Section 23 05 50.

1.2 PERFORMANCE REQUIREMENTS:

A. Provide vibration isolation on all motor driven equipment, plus connected piping and ductwork.

B. The following equipment shall be provided with vibration isolators:
   1. Indoor Heat Recovery Units.
   2. Indoor Air Handling Units.
   3. Inline Exhaust Fans.
   4. Water-Cooled Chillers.
   5. Pumps.
   6. Unit Heaters.
   7. Chiller Suspended Piping.

C. Provide minimum static deflection of isolators for equipment as follows, unless noted otherwise:
   1. 400 – 600 rpm: 3.5 inch
   2. 601 – 800 rpm: 2 inch
   3. 801 – 900 rpm: 1 inch
   4. 901 – 1500 rpm: 0.5 inch
   5. Over 1500 rpm: 0.2 inch

1.3 SUBMITTALS:

A. Product Data: Include load deflection curves for each vibration isolation device indicated.

B. Shop Drawings: Include the following:
   1. Design Calculations: Calculate requirements for selecting vibration isolators for individual pieces of equipment (unit weight and distribution, isolator type and deflection, isolator weight rating).

1.4 SEISMIC RETRAINT REQUIREMENTS:

A. Refer to Section 23 05 50 – Mechanical Seismic Control, for requirements for piping, ductwork and all system appurtenances (including weight of normal operating contents) that shall be adequately restrained to resist seismic forces. For seismic restrained vibration isolators provided under this Section, coordinate the isolator type and strength specifications with the engineering requirements as determined under the seismic design for the project location.

1.5 QUALITY ASSURANCE:

A. Welding: Qualify procedures and personnel according to AWS D1.1, “Structural Welding Code—Steel.”

PART 2 - PRODUCTS

2.1 MANUFACTURERS

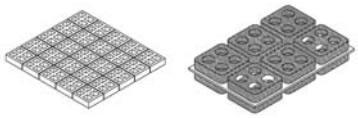
A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VIBRATION ISOLATORS

A. Manufacturers:
   1. Amber/Booth Company, Inc.
   2. B-Line Systems, Inc.
   3. California Dynamics Corp.
   4. Isolation Technology, Inc.
   5. Kinetics Noise Control, Inc.
   6. Mason Industries, Inc.
   7. Vibration Eliminator Co., Inc.
   8. Vibration Isolation Co., Inc.
   9. Vibration Mountings & Controls/Korfund.
   10. Vibro-Acoustics

B. Type EP: Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
   1. Material: Bridge-bearing neoprene, complying with AASHTO M 251.
   2. Minimum ¾" thick.
   3. Max Loading 60 PSI.

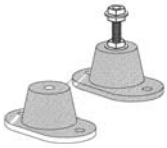
C. Type EM: Elastomeric Mounts: Double-deflection type, with molded, oil-resistant rubber or



ELASOTOMERIC PAD
EP

neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

D. Type ER: Restrained Elastomeric Mounts: All-directional elastomeric mountings with seismic



ELASOTOMERIC MOUNTS
EM

restraint.
   1. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.
   2. Neoprene: Shock-absorbing materials compounded according to, the standard for bridge-bearing neoprene as defined by AASHTO.

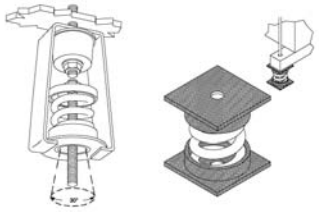
RESTRAINED (SEISMIC)
ELASOTOMERIC MOUNTS
ER

E. Type EH: Elastomeric Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

F. Type SH: Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
   1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

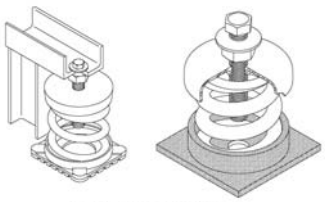
ELASTOMERIC HANGER
EH

   6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.



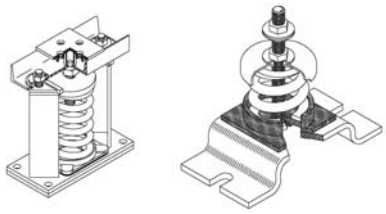
SPRING HANGER
SH

G. Type OS: Open Spring Isolators: Freestanding, laterally stable, open-spring isolators.
   1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   3. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
   4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   5. Baseplates: Factory drilled for bolting to structure and bonded to ¼-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig.
   6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.



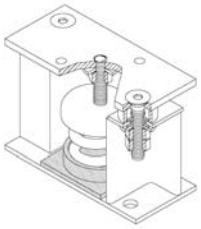
OPEN SPRING
OS

H. Type RS: Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to ¼-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.



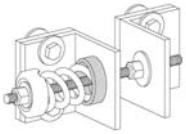
RESTRAINED SPRING
RS

I. Type SS: Seismic Spring Mounts: Housed spring isolator with integral seismic snubbers.
   1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
   2. Base: Factory drilled for bolting to structure.
   3. Snubbers: Vertically adjustable to allow a maximum of ¼-inch (6-mm) travel before contacting a resilient collar.



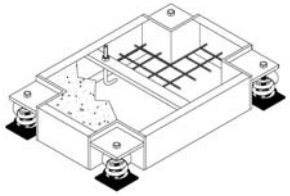
SEISMIC SPRING
SS

J. Type TR: Thrust Restraint: Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop. Include rod and angle-iron brackets for attaching to equipment.
   1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   7. Coil Spring: Factory set and field adjustable for a maximum of ¼-inch movement at start and stop.



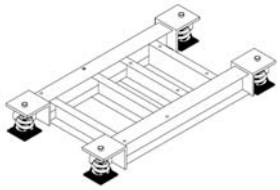
THRUST RESTRAINT
TR

K. Type IB: Inertia Base.
   1. Concrete filled base sized to support equipment without overhanging structural steel members that form perimeter framing. Cutout in center may be provided with structural member interior section to adjust base weight if necessary. Total mass of base shall not be less than two times the total weight of all equipment mounted on base unless otherwise indicated. Submit calculations for base deflection. Deflection shall be in accordance with 1995 ASHRAE Handbook, Vibration Isolation. Furnish with preset embedded anchor bolts and pipe sleeves for fan and motor slide rail or other equipment attachment. Size base to support suction elbow of end suction pumps and suction and discharge elbow of horizontal split case pumps, unless flexible neoprene elbows are used. Use T-shape where necessary to conserve weight and size.



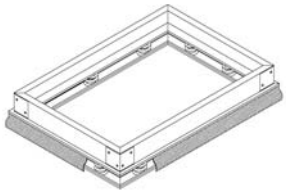
INERTIA BASE
IB

L. Type SB: Structural Steel Base.
   1. Structural steel rectangular base with cross members to prevent twisting where longest beam dimension exceeds 6 feet. Use height-saving brachets for side mounting of isolators.



STRUCTURAL BASE
SB

M. Type IRC: Spring Isolation Roof Curb
   1. Custom spring isolation roof curb to be provided for roof mounted air handling units. Coordinate curb type, dimensions, etc. with RTU equipment manufacturer.



SPRING ISOLATION
ROOF CURB
IRC

N. Type NG: Neoprene Gasket
   1. Neoprene gasket to be provided on roof curb mounted centrifugal exhaust fans between curb framing and fan base assembly.

O. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of ½-inch- thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

P. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes separated by a minimum of ½-inch- thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide in accordance with manufacturers instructions.
B. Anchor isolators to equipment and structure.
C. Connect all associated piping, ductwork and wiring with flexible connectors (unless specifically noted or detailed otherwise).
D. Install seismic snubbers on isolated equipment when installed in seismic rated systems. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
E. Install resilient bolt isolation washers on equipment anchor bolts.
F. Connect wiring to isolated equipment with flexible hanging loop.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Test isolator deflection.
   2. Inspect minimum snubber clearances.

3.3 ADJUSTING

A. Adjust isolators after piping systems have been filled and equipment is at operating weight.
B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
C. Attach thrust limits at centerline of thrust and adjust to a maximum of ¼-inch movement during start and stop.
D. Adjust active height of spring isolators.
E. Adjust snubbers according to manufacturer's written recommendations.
F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

3.4 VIBRATION ISOLATOR RESTRAINT SCHEDULE:

A. Refer to Section Mechanical Seismic Controls for seismic restraint requirements for equipment, piping and ductwork.
B. See plans for additional details and or Vibration Isolator Schedules which shall take precedence over the following default table.

DEFAULT VIBRATION ISOLATOR SCHEDULE

EQUIPMENT/ SYSTEM	MOUNTING LOCATION	WEIGHT (LBS)	MOUNTING TYPE/ LOCATION			FACTORY INSTALLED INTERNAL VIB. ISOL.	VIBRATION ISOLATOR		SERVICE CONNECTIONS			NOTES
			FLOOR		SUSPENDED		TYPE See Note 1	STATIC DEFL. (“)	FLEXIBLE			
			SLAB ON-GRADE	ELEVATED STRUCTURE					DUCT	PIPE	ELECTRICAL	
AHU	SUSPENDED				X		SH	2.5”	X	X	X	
AHU	FLOOR		X			RS	EP	50	X			

								Duro				
AHU	FLOOR			X		RS	EP	50 Duro	X			
FAN COIL	FLOOR			X			EP	50 Duro	X	X	X	
FAN COIL	SUSPENDED				X		EH	50 Duro	X	X	X	
CENTRIFUGAL EXHAUST FAN	ROOF			ROOF			NG	NA				
UTILITY SET EXHAUST FAN	ROOF			ROOF			EM	50 Duro	X		X	
EXHAUST FAN	SUSPENDED				X		SH	1”	X		X	
EXHAUST FAN < 1/4 HP	SUSPENDED				X		EH	50 Duro	X		X	
PUMPS	BASE MTD		X				EP	50 Duro		X	X	
PUMPS	IN-LINE				X		N/R	NA				
PUMPS	BASE MTD			X			IB	2”		X	X	
CHILLER	FLOOR		X				RS	?		X	X	
CHILLER	OUTDOOR		X				EP	50 Duro				
CHILLER	FLOOR/ROOF			X			SB/RS	2.5”		X	X	
Notes: Vibration isolators shall be sized and selected by isolator manufacture based on application, equipment weight and distribution, unit operating speed, mounting configuration, structural span (where applicable).												

END OF SECTION 23 05 48

SECTION 23 05 50 - MECHANICAL SEISMIC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Seismic restraints for HVAC air distribution systems, hydronic piping and HVAC equipment.
   2. Seismic restraints for plumbing piping and equipment.
   3. Seismic design criteria.

B. Delegated Design Requirements:
   1. Design and installation of seismic restraint and anchoring systems and locations shall be Contractor furnished and installed.
      a. Only select systems and equipment located in Seismic Design Category “C” shall be seismically braced and anchored.
      b. All mechanical systems and equipment in Seismic Design Category “D” or greater shall be seismically braced and anchored. Exceptions are described herein.

1.2 RELATED SECTIONS

A. Division 22 - PLUMBING

1.3 REFERENCES

A. Definitions & Referenced Standards: As specified in Section 230000 – HVAC General Provisions. Use current version of each referenced standard.
   1. Building Codes: IBC, ASCE7, Applicable State and Local Codes
   2. FEMA: Federal Emergency Management Agency
   3. FEMA Seismic Restraint Installation Manuals 412 & 414
      a. FEMA 412: Installing Seismic Restraints for Mechanical Equipment
      b. FEMA 414: Installing Seismic Restraints for Duct and Pipe
   4. S_1: Mapped Long Period Seismic Acceleration Coefficient IBC
   5. Ss: Mapped Short Period Seismic Acceleration Coefficient IBC
   6. VISCMA: The Vibration Isolation and Seismic Control Manufacturers Association has developed Testing and Rating Standards for Seismic Restraint Components that comply with Code and ASHRAE based requirements.
   7. VISCMA 102-2007: Static Qualification Standards for Obtaining a VISCMA Compliant Seismic Component Rating.
   8. ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.)
   9. ASHRAE Applications Handbook: Seismic and Wind Restraint Design Chapter
   10. ASHRAE SPC-171: Method of Test for Seismic Restraints

1.4 SUBMITTALS

A. Product Data: Include VISCMA Seismic Rating documentation for each seismically rated isolator or restraint component. Include ratings for horizontal, vertical and combined loads.

B. Delegated-Design Submittal: For seismic restraints required to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation and seismic forces required to select seismic restraints.
   2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
   3. Seismic Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the 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. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
d. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
e. Detailed description of the specified equipment anchorage devices on which the certification is based.

C. Shop Drawings:
1. Include at a minimum basic equipment layout, length and width dimensions, and installed operating weights of the equipment to be restrained.
2. Floor plans showing equipment, ductwork and piping with indication of required seismic restraint locations and types with cross-reference to applicable details and bill of material.
3. Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Qualification Data: For seismic design engineer.

1.5 QUALITY ASSURANCE

A. Seismic Design Engineer: Engage the services of a licensed professional engineer to provide engineering of ALL seismic restraint and anchoring systems and locations. Professional Engineer shall have at least 5 years' experience in the design of seismic restraints.

B. Comply with seismic restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code—Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency, such as VISCMA, acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.6 PERFORMANCE REQUIREMENTS

A. Project Specific Seismic Loading - See Structural Plans for the following:
1. Seismic Design Category, SDC
2. Site Class
3. Seismic Occupancy Category
4. Short Period Spectral Response Acceleration (SS)
5. 1-Second Spectral Response Acceleration (S1)
6. Short Period Spectral Response Coefficient (SDS)
7. 1-Second Spectral Response Coefficient (SD1)

B. Importance Factors (I_P):
1. $I_P = 1.5$
a. Natural gas & fuel oil piping.
b. Laboratory exhaust systems or other hazardous fumes.
c. Boilers, furnaces & flue systems.
d. Medical gas piping & equipment.
e. Smoke removal & fresh air systems & equipment.
f. Fire sprinkler piping & systems.
g. Hospital HVAC systems.

h. High pressure steam piping.
i. All systems in Seismic Occupancy Category IV (Hospitals; fire, rescue, ambulance, police stations; emergency operation centers; etc.)

2. $I_P = 1.0$
   a. All other mechanical and plumbing systems.

C. Seismic Restraint Requirements Mechanical and plumbing systems and components shall be seismically restrained according to the following criteria:
   1. Seismic Design Category A or B:
      a. No seismic restraints required on mechanical or plumbing systems.
   2. Seismic Design Category C:
      a. Mechanical Systems/Equipment with an Importance Factor, $I_P = 1.0$: No seismic restraint required.
      b. Mechanical Systems/Equipment with an Importance Factor, $I_P = 1.5$: seismic restraints and design required (exemptions listed below).
   3. Seismic Design Category D, E and F:
      a. Seismic restraints and design required for all mechanical and plumbing systems and equipment regardless of Importance Factor (exemptions listed below). See Delegated Design Submittal Requirements.
   4. Exemptions:
      a. Mechanical and plumbing components are exempt from the seismic restraint requirements where all of the following apply:
         1) Importance Factor $I_P = 1.0$:
         2) The system/component is positively attached to the structure
         3) Flexible connections are provided between the component and the associated system (piping, ductwork, etc), and either:
            a) The component weights 400 lbs or less, and has a center of mass located 4 feet or less above floor, or
            b) The component weighs 20 lbs, or less or 5 lbs/ft for piping and ductwork distribution.
      b. Mechanical and plumbing systems (ductwork and piping) are exempt from the seismic restraint requirements where the systems are supported within 12" of the structure (top of pipe/duct to structure) along the entire length of run.

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Amber/Booth Company, Inc., The VMC Group.
   2. The VMC Group
   3. Cooper B-Line, Inc.; a division of Cooper Industries
   4. Hilti, Inc.
   5. Kinetics Noise Control
   6. Vibration Elimination Company, Inc.
   7. Mason Industries
   8. Tolco Incorporated; a brand of NIBCO Inc.
   9. Unistrut; Tyco International, Ltd.
   10. Vibro-Acoustics
   11. M.W. Sausse & Co. Inc.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by VISCMA or an agency acceptable to authorities having jurisdiction.

C. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
E. Restraint Cables: ASTM A 603 galvanized- or ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
G. 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.
H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
I. Mechanical Anchor Bolts: 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 required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
J. Adhesive Anchor Bolts:
K. Inline Pump Stands: Seismically rated pre-fabricated, pre-drilled and painted pump stands for floor mounted vertical inline pumps. Stands shall fit ANSI flanges and be capable of accepting vibration isolators when required.
L. Seismic Pipe Stands: Seismically rated pre-fabricated and adjustable pipe stand for floor mounted and roof mounted piping.
M. Restrained Spring Isolator: Floor mounted spring isolator with integral restraint capable of withstanding seismic/wind forces. Restraint shall limit movement to a maximum of ¼" in all directions. Isolator housings shall be galvanized and hardware shall be zinc coated or stainless steel for outdoor applications.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by VISCMA or an agency acceptable to authorities having jurisdiction.
B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.
D. Refer to FEMA Manuals 412 & 414 for typical industry standard installation guidelines.
E. Comply with seismic design shop drawings and restraint manufacturers' installation requirements.
F. Ensure all housekeeping pads used are adequately reinforced and are properly dowelled to the building structure, so as to withstand calculated seismic forces. In addition, the size of the housekeeping pad is to be coordinated with the seismic restraint manufacturer to ensure that adequate edge distances exist in order to obtain desired equipment anchor capacities.

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
B. Equipment Restraints:
   1. Install resilient bold isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
C. Piping Restraints:
   1. Comply with requirements in MSS SP-127.

2. Space lateral supports at a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c. for ductile (i.e. steel) piping. Brace a change of direction longer than 12 feet.
3. Space lateral supports at a maximum of 20 feet o.c., and longitudinal supports a maximum of 40 feet o.c. for non-ductile (i.e. cast iron) piping. Brace a change of direction longer than 8 feet.

D. Ductwork Restraints:
1. Space lateral supports at a maximum of 30 feet o.c. and longitudinal supports a maximum of 60 feet o.c. Brace a change in direction longer than 10 feet.

E. Install cables so they do not bend across edges of adjacent equipment or building structure.

F. Install seismic-restraint devices using methods approved by VISCMA or an agency acceptable to authorities having jurisdiction, providing required submittals for component.

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

H. 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. Restrain connections to the structure flanges with non-seismically rated beam clamps are not permitted.

I. Rigid type restraints shall not be used on components that are to be supported by spring isolators.

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

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections:
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

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

C. Prepare test and inspection reports.

D. Restraint Manufacturer Review: The restraint manufacturer or local representative shall review the restraint installations once completed by the installing contractor. The manufacturer shall submit a certification that the restraints are in compliance with their design and applicable code

requirements. Any installation discrepancies shall be fixed at the installing contractor's expense.

3.4 ADJUSTING

A. Adjust isolators after piping 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.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 05 50

SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
- A. This Section includes the following mechanical identification materials and their installation:
  1. Equipment markers.
  2. Access panel and door markers.
  3. Pipe markers.
  4. Valve tags.
  5. Above ceiling access T-bar markers.
  6. Duct Labels.

1.2 REFERENCES
- A. American Society of Mechanical Engineers (ASME):
  1. ASME A13.1 – Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS
- A. Product Data: For each type of product indicated.
- B. Lists:
  1. Provide lists of equipment labels and ID tags; pipe labels with system abbreviation, name & pipe size; and valve label ID tags with duty, for engineer review and approval.

1.4 QUALITY ASSURANCE
- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
- A. Approved pipe, valve and equipment label manufacturers.
  1. Seton.
  2. W. H. Brady.
  3. Marking Services Inc.
  4. Trophy House Pros, Signs and Engraving
  5. Brimar Industries.

2.2 EQUIPMENT IDENTIFICATION DEVICES
- A. Equipment Markers: 1/16” thick, engraved, color-coded plastic, phenolic or aluminum.
  1. Data: Name and equipment tag # listed on schedule.
  2. Size: 4 by 6 inches for large equipment, 2 by 3 inches for terminal units. Lettering size proportional.
  3. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

  4. Tag Colors:
     a. Heating devices: Red with White Letters
     b. Cooling devices: Blue with White Letters

c. Fans & AHUs: Black with White Letters.
d. Pumps & Hydronic Devices: Green with White Letters.

B. Access Panel and Door Markers: Same as equipment markers. Label items or equipment that is access through the door or panel.

2.3 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pre-tensioned Pipe Markers: Pre-coiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.4 PIPING IDENTIFICATION PIPELINE PAINTING

A. Unless indicated otherwise, all piping, both insulated and not insulated, shall be color coded with pipeline paint. Painting shall cover all visible sections of piping, fittings, elbows, etc. within chiller plant. Outdoor piping with metal jacketing does not need to be painted, but outdoor uninsulated piping shall be painted.
1. Do not paint removable insulation jackets or pipeline fittings that are not insulated.

B. Pipeline paint shall be latex type paint, suitable for fiberglass ASJ insulation and PVC pipe jackets.

C. Pipeline paint colors shall be the same as for the pipe identification labels as indicated above.
   a. CWS: Chilled Water Supply. Color: Blue.
   b. CWR: Chilled Water Return. Color: Blue.
   c. CSFT: Condenser Supply From Tower. Color: Light Green.
   d. CRTT: Condenser Return to Tower. Color: Light Green.
   e. CEM: Chemical Treatment Lines. Color: Purple.
   f. SOW: Soft Water (Make-up). Color: Light Blue.
   g. FPW: Fire Protection Water. Color: Light Blue.
   h. Drains & Auxiliaries: Color: White.

2.5 VALVE TAGS (WITHOUT SERVICE DATA)

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.
   1. Material: 0.032-inch- thick brass or aluminum.
   2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.
   3. Labeling: System tag (HW, CW, Steam, etc.) and valve number.

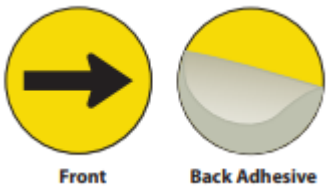
2.6 VALVE TAGS (WITH SERVICE DATA)

A. Valve Tags: Stamped or engraved with white letters for piping system abbreviation and valve duty description. Provide hole for fastener.
   1. Material: 1/8-inch thick 3-ply plastic, brass or aluminum.
   2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.
   3. Size: 3” x 3” minimum.
   4. Tag Body Color:
      a. Hydronic heating, steam and condensate: Red.
      b. Chilled Water: Blue.
      c. Make-up water, drain: Green.
   5. Labeling:
      a. System abbreviation and valve size.
      b. Valve duty and/or building served: (i.e. shut-off, warm-up, drain, blow-down, etc.).
      c. Service: NO (normally open), NC (normally closed), Bypass, etc.

2.7 T-BAR CEILING LABELS

A. T-Bar ceiling labels tape shall be 3/4-inch diameter plastic tags with self-adhesive backing and mounted to t-bar grid at a point closest to the item to be accessed. Provide with directional arrows indicating which ceiling tile is the most appropriate for removal. Brimar Industries (Pipemarker.com) or equal.

B. Ceiling Label Tag Color Scheme:
   1. HVAC Isolation Valves: BLUE.
   2. Plumbing Isolation Valves: GREEN.
   3. HVAC Units/Filter Access: ORANGE.
   4. Control Dampers, OSA Valves, etc: YELLOW.
   5. Fire or Smoke Dampers: RED.
   6. Waste or Roof Drain Clean-outs: WHITE.



2.8 DUCTWORK LABELS

A. Self-Adhesive vinyl markers with air flow directional arrows. Label to identify air handling unit/system and type of air flow, e.g." HRU-1 Supply Air", "EF-1 Exhaust Air", etc.

B. Label Color Scheme:

1. Supply Air (Tempered Air): Red label with white lettering.
2. Return Air: Yellow label with black lettering.
3. Exhaust Air: Green label with white lettering.
4. Outside Air: Blue label with white lettering.

PART 3 - EXECUTION

3.1 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pre-tensioned pipe markers. Use size to ensure a tight fit.
2. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
3. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and non-accessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.2 EQUIPMENT IDENTIFICATION

A. Install equipment markers with permanent adhesive or screws on or near each major item of mechanical equipment (all equipment scheduled and tagged on the drawings).
   1. Data: Name and equipment tag # listed on schedule.
   2. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
      a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
      b. Fuel-burning units, including boilers, furnaces, etc.
      c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
      d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
      e. Fans, blowers, air handlers, fan coils, heat pumps and terminal units.
      f. Packaged HVAC central-station and zone-type units.
      g. Tanks and pressure vessels.
      h. Humidifiers, water-treatment systems, and similar equipment.

3.3 VALVE-TAG INSTALLATION

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

B. Valve-Tag List: Provide printed valve tag list with the following information for each valve:
   1. System abbreviation as indicated on plans, e.g. HWS, CWS, HPS, PC, etc.
   2. Unique valve number for each system valve.
   3. Size of valve.
   4. Type of valve, e.g. ball valve, gate valve, butterfly valve, etc.
   5. Duty of valve: e.g. shut-off, bypass, drain, etc.
   6. Location of valve: Room number and/or name, and location, e.g. near boiler, at ceiling, etc.

3.4 ABOVE CEILING ACCESS TBAR TAGS

A. Provide a colored label appropriate to the service being accessed above the ceiling at t-bar ceilings and access doors in hard ceilings. Point directional arrow towards the most accessible ceiling tile that leads to the device to be serviced.

3.5 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels on all duct systems, including ductwork above lay-in ceilings and inside accessible duct chases. Affix duct label with air flow direction arrows on most visible section of duct. Affix to bare or insulated ductwork as necessary. Clean surfaced before installing labels. Install in the following locations:
   1. Near connections to each piece of equipment, inlets and outlets.
   2. Near branch take-offs.
   3. At wall and floor penetrations. Locate on both sides of penetration.
   4. Spaced at a maximum of 25 feet along each duct run. Reduce to intervals of 10 feet in areas of congested ductwork, piping or equipment.

3.6 ADJUSTING AND CLEANING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

B. Clean faces of mechanical identification devices and frames of valve schedules.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING (TAB)

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes TAB to produce design flows for the following:
   1. Air Systems:
      a) Constant-volume air systems.
      b) Dedicated Outside Air Systems (DOAS).
      c) Variable-volume air systems.
   2. Hydronic Piping Systems:
      a) Constant-flow systems.
      b) Variable-flow systems.
      c) Primary-secondary systems.
   3. Exhaust systems, hoods and Commercial Kitchen Hoods.
   4. Fume hoods and Bio-Safety cabinet systems.
   5. Space pressurization.
   6. HVAC equipment quantitative-performance settings.
   7. Domestic water system hot water recirculation balance.
   8. Motors.
   9. Heat-Transfer Coils.
   10. Verifying that automatic control devices are functioning properly.
B. Air Barrier and Building Enclosure Testing HVAC Preparation.
C. Reporting results of activities and procedures specified in this Section.
D. Pressure Testing: Refer to individual mechanical specifications for pressure testing and operating requirements.

1.2 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.
C. Six weeks prior to starting TAB, submit the qualifications of the site technician for the project, including the name of the contractors and facility managers of recent projects the technician on which was lead.
D. Provide formal progress reports and deficiency reports weekly.
E. Communicate in writing all set-point and parameter changes made or problems and discrepancies identified during TAB that affect the control system setup and operation.
F. Provide a draft TAB report within two weeks of completion. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings.
   1. Provide a list of all components and systems that perform out of specified parameters.
   2. Provide any requested data, gathered, but not shown on the draft reports.
G. Provide a final TAB report for the Owner’s Representative and Commissioning Authority with details. Provide final information as requested in draft TAB report.
   1. Identify the following:
      a) Systems or subsystems for which final balancing is complete.
      b) Status of deficiencies and balancing issues encountered, including corrective actions taken.
      c) Plan & Schedule for completion of unfinished work.
H. Commissioning Authority (CA):
   1. The CA will be consulted regarding TAB site technician for the project.
   2. The CA will be provided with a copy of the draft TAB report as well as the final TAB report.

3. Participate with the CA in checking performance on the original TAB.
4. The CA may verify the accuracy of the TAB work prior to commencing Functional Performance testing activities that may be adversely affected by improper balancing

1.3 SUBMITTALS

A. Strategies and Procedures Plan:
   1. Submit the outline for the TAB Strategies and Procedures Plan six weeks prior to starting TAB procedures.
   2. The submitted plan will include:
      a) Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.
      b) An explanation of the intended use of the DDC. The controls contractor will comment on feasibility of the plan.
      c) All field checkout sheets and logs to be used that list each component to be tested, adjusted and balanced with the data cells to be gathered for each.
      d) Discussion of what notations and markings will be made on the duct and piping drawings during the process.
      e) Final test report forms to be used.
      f) Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / sub-main proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the waterside.
      g) List of all airflow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      h) Details of how total flow will be determined (Air: sum of terminal flows via DDC calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).
      i) The identification and types of measurement instruments to be used and their most recent calibration date.
      j) Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.
      k) Confirmation that TAB understands the outside air ventilation criteria under all conditions.
      l) Details of whether and how minimum outside air cfm will be verified and set, and for what level (total building, zone, etc.).
      m) Details of how building static and exhaust fan / relief damper capacity will be checked.
      n) Proposed selection points for sound measurements and sound measurement methods.
      o) Details of methods for making any specified coil or other system plant capacity measurements.
      p) Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.
      q) Details regarding specified deferred or seasonal TAB work.
      r) Details of any specified false loading of systems to complete TAB work.
      s) Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.
      t) Details of any required interstitial cavity differential pressure measurements and calculations.

B. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

1.4 QUALITY ASSURANCE

A. TAB Firm Qualifications: An independent testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) in those testing and balancing disciplines specified for this project.

B. Prequalified balancing contractors are:
   1. Air Commander
   2. TestComm
   3. Riley Engineering

C. Report Certification: Certify TAB field data reports in accordance with NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, 5.2.2 Report Certification." This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. NEEB's Quality Assurance Program (QAP): TAB work shall be performed in accordance with NEBB standards. The certified TAB firm will make application to the NEBB Office for a Certificate of Conformance Certification.

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 approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

D. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

F. Examine system and equipment test reports.

G. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

I. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls are ready for operation.

J. Examine Fan Coil Units to verify that they are accessible and their controls are connected and functioning.

K. Examine strainers for clean screens and proper perforations.
L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
N. Examine system pumps to ensure absence of entrained air in the suction piping.
O. Examine equipment for installation and for properly operating safety interlocks and controls.
P. Examine automatic temperature system components to verify the following:
    1. Dampers, valves, and other controlled devices are operated by the intended controller.
    2. Dampers and valves are in the position indicated by the controller.
    3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
    4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
    5. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
    6. Sensors are located to sense only the intended conditions.
    7. Sequence of operation for control modes is according to the Contract Documents.
    8. Controller set points are set at indicated values.
    9. Interlocked systems are operating.
    10. Changeover from heating to cooling mode occurs according to indicated values.
Q. 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.
R. If conditions are discovered that prevent the Testing Agent from performing the test, the Testing Agent shall notify MSI Engineers (509-624-1050) prior to leaving the site.

3.2 PREPARATION

A. Complete system readiness checks and prepare system readiness reports. Verify the following:
    1. Permanent electrical power wiring is complete.
    2. Hydronic systems are filled, clean, and free of air.
    3. Automatic temperature-control systems are operational.
    4. Equipment and duct access doors are securely closed.
    5. Balance, combination fire & smoke, and fire dampers are open.
    6. Isolating and balancing valves are open and control valves are operational.
    7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
    8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
    1. Where conditions or situations arise that are not covered by the standards, or where system dynamics and performances are not as intended or expected, the Engineer reserves the right to modify the NEBB TAB procedures and standards for the benefit of the final system operation. The balancing agency shall seek guidance from the Engineer when such conditions develop.
B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to Specifications.
C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
B. Prepare schematic diagrams of systems' "as-built" duct layouts.
C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
F. Verify that motor starters are equipped with properly sized thermal protection.
G. Check dampers for proper position to achieve desired airflow path.
H. Check for airflow blockages.
I. Check condensate drains for proper connections and functioning.
J. Check for proper sealing of air-handling unit components.
K. Check for proper sealing of air duct system.
L. Check all fans for proper fan rotation.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS: (Fan Coil Units, Air Handling Units and Exhaust Systems)

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
    1. Measure fan static pressures to determine actual static pressure as follows:
        a) Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
        b) Measure static pressure directly at the fan outlet or through the flexible connection.
        c) Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
        d) Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
    2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
        a) Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
    3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
    4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
    5. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Make required pulley size changes or adjustments to pulley sizes, and electrical connections to accommodate fan-speed changes.
    6. 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 modes to determine the maximum required brake horsepower.
B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
    1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
        a) Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
    2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.
   1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than the dampers at air terminals.
   1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
   2. Adjust patterns of adjustable outlets for proper distribution without drafts.

E. Where applicable, adjust counterbalanced relief dampers to maintain a maximum room pressure of .05”w.g. in the economizer mode.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS: (VAV Air Handlers, DOAS Heat Recovery Ventilator Units)

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure fan static pressures to determine actual static pressure as follows:
      a) Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
      b) Measure static pressure directly at the fan outlet or through the flexible connection.
      c) Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
      d) Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
   2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
      a) Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
   3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
   4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
   5. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Make required pulley size changes or adjustments to pulley sizes, and electrical connections to accommodate fan-speed changes.
   6. 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 modes to determine the maximum required brake horsepower.

B. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

C. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Set outside-air dampers at the minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
   2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the dritical terminal unit is not less than the sum of terminal-unit manufacturer’s recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air systems.
5. Set terminal units at minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
   a) If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure is maintained at the most critical unit.
8. Record the final fan performance data.

3.7 PROCEDURES FOR DOAS (Dedicated Outside Air Systems) DISTRIBUTION SYSTEMS

A. Test and balance main DOAS air handling unit and distributed Outside Air Valves as indicated above for Variable Air Volume systems.
   1. Test Outside Air Valves at design (occupied) air flow, design full economizer air flow, and at unoccupied minimum or CO2 satisfied air flow levels. Conduct these tests modes simultaneously for all Outside Air Valves to vertify that the DOAS air handling unit and controls can properly deliver the wide diversity in air flow rates.

B. Where the DOAS system is serving constant volume type terminal units, such as fan coils and heat pumps, the terminal unit air flows shall be tested both with the DOAS Outside Air Valve in operation (occupied and economizer air flow rates) and in the unoccupied mode, with no outside air flow. The terminal unit air flow and room air outlets served by the terminal unit, shall be balanced with the Outside Air Valve in the normal occupied air flow mode. Terminal unit and air outlet flow rates at the other modes (full economizer outside air flow and zero outside air flow (full recirc.)) shall be measured and recorded for documentation purposes.

3.8 PROCEDURES FOR COMMERCIAL KITCHEN HOODS, SHOP EXHAUST HOODS, PAINT BOOTHS, FUME EXTRACTORS AND SAW DUST COLLECTION SYSTEMS.

A. Measure, adjust, and record the airflow of each hood and/or exhaust system inlet. Measure airflow by duct Pitot-tube traverse. If a duct Pitot-tube traverse is not possible, provide an explanation in the report of the reason(s) why and also the reason why the method used was chosen.
   1. Install welded test ports in the sides of the exhaust duct for the duct Pitot-tube traverse. Install each test port with a threaded cap that is liquid tight.

B. After balancing is complete, do the following:
   1. Measure and record the static pressure at the hood exhaust-duct connection.
   2. Measure and record the hood face velocity. Make measurements at multiple points across the face of the hood. Perform measurements at a maximum of 12 inches between points and between any point and the perimeter. Calculate the average of the measurements recorded. Verify that the hood average face velocity complies with the Contract Documents and governing codes.
   3. Check the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to room airflow patterns to achieve optimum results.

C. Visually inspect the hood exhaust duct throughout its entire length in compliance with authorities having jurisdiction. Begin at the hood connection and end at the point it discharges outdoors. Report findings.
   1. Check duct slopes as required.
   2. Verify that duct access is installed as required.
   3. Verify that point of termination is as required.
   4. Verify that duct air velocity is within the range required.
   5. Verify that duct is within a fire-rated enclosure.

D. Report deficiencies.

3.9 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.10 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

1. When the available developed pump head is sufficiently greater than the actual required system pressure drop head, more than 25%+/-, the balancer shall determine and recommend that the pump impeller(s) be trimmed to a point on the pump curve that better matches actual field conditions. Excess system pressure drop is indicated when the main system flow balance valve(s) have to be throttled excessively to achieve design flow rates.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.11 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two and three way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

B. Measure/validate flow through pressure independent control valves utilizing the venturi or the PT ports on the manual balancing valve downstream of the valve. Do not use the manual balancing valve to adjust flow.

3.12 PROCEDURES FOR DOMESTIC HOT WATER RECIRCULATION SYSTEM

A. Balance domestic hot water recirculation system similar to hydronic system balance as noted above. Set or confirm that pressure independent and pressure dependent flow balance devices are correctly installed and adjusted to design flow rates. Measure recirculation pump flow rate and check to make sure it matches the sum of the individual recirculation circuits and adjust accordingly.

B. Measure hot water supply distribution temperatures at all remote fixtures in each wing and measure outlet temperature and time it takes for hot water to flow from intitial valve opening. Record temperatures and times for each remote fixture.

3.13 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer, model, and serial numbers.
   2. Motor horsepower rating.
   3. Motor rpm.
   4. Efficiency rating.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.14 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.

3.15 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.16 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.
D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
E. Check free travel and proper operation of control devices such as damper and valve operators.
F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
G. Check the interaction of electrically operated switch transducers.
H. Check the interaction of interlock and lockout systems.
I. Check main control supply-air pressure and observe compressor and dryer operations.
J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.17 AIR BARRIER AND BUILDING ENVELOPE TESTING HVAC PREPARATION

A. Refer to Division 1 section “Testing and Inspection Services” for air leakage testing requirements and additional information required to complete the testing.
B. HVAC Preparation: As specified in NEBB BET Procedural Standards – Table 8.1.
   1. Seal exhaust fans with back draft dampers.
   2. Seal supply fans with back draft dampers.
   3. Close furnace room door (for furnace outside the test zone).
   4. Close combustion air intake dampers for boilers.
   5. Turn off recirculating air handlers, make-up air units, energy recovery units, supply fans, furnaces, fan coil units, boilers, gas hot water heaters and exhaust fans - All equipment requiring combustion air (including kitchen equipment).
   6. Seal outdoor air inlets and exhaust outlets (by dampers and/or masking) inside the test zone.
   7. Close and mask motorized dampers.
   8. Mask undampered HVAC openings.
   9. Seal ventilators designed for continuous use.
   10. Seal supply and exhaust ventilator dampers.
   11. Seal off ventilation to other zones.
   12. Seal window air conditioners and through wall air conditioners to outside air vent.
   13. Fill floor drains and plumbing traps.
   14. Seal all HVAC ducts going from inside the test zone to outside the test zone and back into the test zone.
   15. Isolate movement and mask gravity dampers.
C. Provide a responsible HVAC technician with the authority to place the HVAC system in the correct mode for the pressure test. Allow the testing agency unhindered access to mechanical rooms, air handlers, exhaust fans, and outdoor air and exhaust dampers.
D. Provide a responsible technician with access to and the authority to reset circuit breakers.
E. Close and latch all windows and doors and allow no access in the test envelope during the test.
F. Assist the testing agency representative in removing all door hardware and other objects that interfere with test equipment set-up.
G. No work shall be performed in the test area while the test is in progress. Comply with ASTM E779-10, 7.0, to ensure any occupational hazards associated with operating test fans are eliminated.

3.18 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.
   3. Heating-Water Flow Rate: Plus or minus 10 percent.
   4. Cooling-Water Flow Rate: Plus or minus 5 percent.

3.19 FINAL REPORT

A. General: Provide electronic pdf reporttabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of TAB firm.
   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 firm who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:
      a) Indicated versus final performance.
      b) Notable characteristics of systems.
      c) Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer, type size, and fittings.
   14. Notes to explain why certain final data in the body of reports varies from indicated values.
   15. Test conditions for fans and pump performance forms including the following:
      a) Settings for outside-, return-, and exhaust-air dampers.
      b) Conditions of filters.
      c) Cooling coil, wet- and dry-bulb conditions.
      d) Face and bypass damper settings at coils.
      e) Fan drive settings including settings and percentage of maximum pitch diameter.
      f) Settings for supply-air, static-pressure controller.
      g) Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outside, supply, return, and exhaust airflows.
   2. Water and steam flow rates.
   3. Duct, outlet, and inlet sizes.
   4. Pipe and valve sizes and locations.
   5. Terminal units.
   6. Balancing stations.
   7. Position of balancing devices.

3.20 TRAINING

A. TAB shall meet for 4 hours with Owner’s personnel after completion of TAB and instruct them on the following:
   1. Final TAB report, explaining the layout and meanings of each data type.

2. Any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
5. Other salient information that may be useful for facility operations, relative to TAB.

3.21 ADDITIONAL TESTS

A. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 00 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes insulation requirements for HVAC ductwork, hydronic piping as associated tanks, vessels and equipment.

1.2 REFERENCES

A. Insulation values shall conform with the latest edition of the Washington State Energy Code and ASHRAE recommendations.

B. ASTM International:

1. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
2. ASTM C411 – Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
3. ASTM C534 – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
4. ASTM C547 – Standard Specification for Mineral Fiber Pipe Insulation.
5. ASTM C585 – Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
6. ASTM C612 – Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
7. ASTM C665 – Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
8. ASTM C1104 – Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
9. ASTM C1136 – Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
10. ASTM C1338 – Standard Test Method for Determining Fungi Resistance of Insulation materials and Facings.
11. ASTM E84 (NFPA 255) – Standard Test Method for Surface Burning Characteristics of Building Materials.

C. Underwriters Laboratories (UL):

1. UL 723 – Test for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

A. Product Data: Provide product data for each type of insulation product indicated.

B. Shop Drawings: Show details for the following:

1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
3. Removable insulation at piping specialties, valves, equipment connections, and access panels.
4. Application of field-applied jackets.

C. Insulation Schedule: Provide a schedule indicating insulation type and thickness and equivalent R-value for each mechanical system to be insulated. Indicate jacketing type to be utilized.

1.4 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar services for not less than 10 years.

B. Installer’s Qualifications: Firms with at least 5 years successful installation experience on projects with mechanical insulation systems similar to that required for this project.

C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke developed index of 50 or less, as tested by ASTM E84 (NFPA 255) method.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following:
   1. Armacell LLC
   2. CertainTeed Corp.
   3. Foster Products Corp.
   4. IMCOA
   5. Johns Manville Products Corp.
   6. Knauf Fiber Glass GmbH.
   7. Owens-Corning Fiberglas Corp.
   8. Pittsburgh Corning Corp.

2.2 PIPING INSULATION MATERIALS

A. Fiberglass Piping Insulation: ASTM C411, ASTM C547, ASTM C585, ASTM C1136, K = 0.24 @ 100º F mean temperature. HP All Service (White ASJ) vapor retarder jacket with self-sealing longitudinal closure LAP. Equal to Johns Manville Micro-Lok.

B. Elastomeric Piping Insulation: ASTM C534, Type 1, ASTM E84, NFPA 255, UL 723, K = 0.27 @ 75º F Mean temperature. Equal to AP Armaflex pipe insulation.

C. Pipe Fittings:
   1. Fitting Insulation: Fittings, elbows, tees, unions, etc. shall be molded fiberglass fabricated specifically for pipe size, type, and adjacent insulation thickness. Only molded products are acceptable. Equal to Johns Manville Hi-Lo temperature fiber glass insulation inserts.

D. Insulation Fitting Covers:
   1. Subject to compliance with requirements, provide one of the following products or approved equal:
      a. Johns Manville Zeston 2000
      b. Speedline Smoke-Safe
   2. One-piece premolded 0.020” thick white PVC fitting covers fastened as per manufacturer’s recommendations with fiberglass inserts.

2.3 PIPE INSULATION JACKETS

A. PVC Pipe Insulation Jackets:
   1. Subject to compliance with requirements, provide one of the following products or approved equal:
      a. Johns Manville Zeston 2000
      b. Speedline Smoke-Safe
   2. For interior applications, premolded 0.020” thick white PVC wrap covers fastened as per manufacturer’s recommendations.

B. Aluminum jacket pipe insulation shall be 0.016” (0.4MM) thick, stucco embossed finish, with a one mil polyethylene film/forty pound kraft paper integral vapor barrier affixed to the interior of the cover in conformance with ASTM B209. Elbows and fittings shall be jacketed with pre-formed 0.024” thick aluminum covers, with moisture retarder film.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Description: High density compressive-strength insulation insert encased in sheet metal shield. Compressive strength varies (25 to 100 psi) based on insulation material selected and shall be as required to accommodate various hanger types, pipe sizes and materials, and associated loading. Flame/smoke rated at 25/50 for plenum applications. Minimum R-Value per 1” thickness shall be 2.5 for calcium silicate and 5.0 for cellular glass or phenolic insulations.

B. Refer to Section Hangers and Supports for HVAC Piping and Equipment for shield insert requirements.

2.5 PIPE INSULATION REMOVABLE VALVE AND FITTING COVERS

A. Valves and devices subject to service or operational needs shall be insulated with removable type covers. These include: Shut-off valves, balance valves (manual and automatic), control valves, venturis and strainers.

B. Valves sets at terminal unit and air handling unit coil connections shall be covered with pre-insulated valve wraps equal to “No-Sweat” reusable and removable covers. Valve wraps shall consist or 1” thick insulation with a durable vapor barrier jacket material and Velcro closures. Field or shop fabricated valve wraps for terminal unit and smaller AHU valve sets are NOT acceptable.

C. Larger body valves, strainers, etc. shall be covered with custom made or pre-manufactured removable covers utilizing PTFE Fiberglass Composite Jacketing, 16.5 oz/sq. yd minimum density, inside and outside face, or Silcone-coated F.G. cloth with S.S. mesh inner lining, both with fiberglass insulation fill. Assembly shall be double sewn lock stitch with minimum 4 to 6 stitches per inch. Jackets shall be fasteners using hook and loop (Velcro) straps and 1” slide buckles or S.S. lacing hooks with Teflon-coated F.G. drawstrings.

D. Flex hose connections on the chilled water coil connections to terminal units shall be covered with ½” thick elastomeric foam, pre-molded pipe sections, for condensation control.

2.6 DUCTWORK INSULATION WRAP MATERIALS

A. Flexible fiberglass ductwork insulation shall conform to ASTM C411, ASTM C1104, ASTM C665, ASTM C1338, formaldehyde-free, K = 0.25 @ 75º mean temperature. Provide FSK (Alum. Foil-Scrim-Kraft) vapor barrier facing with 2” stapling tab. Equal to Johns Manville Microlite XG.

B. Duct Liner: Products meeting ASTM C1071; K(ksi) value of 0.25 (R=4.0 per inch)at 75 degrees F, coated air side for maximum 5,000 ft/min air velocity, 1.5 psf density.
   1. See Section 23 31 00 - HVAC Ducts.

2.7 DUCT PLENUM INSULATION MATERIALS

A. Rigid fiberglass ductwork insulation shall conform to ASTM C612, type 1A, ASTM C612, type 1B. K = 0.23 @ 75º F mean temperature equal to Johns Manville 800 series spin-glass with FSK (Alum. Foil-Scrim-Kraft) vapor barrier facing. Type 814 at 3.00 pcf density.

2.8 EXTERIOR DUCTWORK INSULATION MATERIALS

A. Rigid Polyisocyanurate Foam Sheating shall conform to ASTM C1289-07 Type II. K = 0.17 @ 75°F mean temperature, equal to Johns Manville R-Panel Roof Insulation. For exterior (outside the building envelope) use only.

2.9 FIRE-RATED DUCT INSULATION SYSTEMS

A. High temperature, flexible, blanket insulation with FSK (Alum. Foil-Scrim-Kraft) jacket that is UL tested and certified to provide a 2-hour fire rating, equal to 3M fire barrier duct wrap 615+.

2.10 DUCTWORK JACKETING & WEATHERPROOFING

A. Self-adhering cover: Membrane shall be a pre-manufactured self-adhering product with an UV resistant, stucco embossed facing. Water valve transmission of the installed product shall be 0.020 perms or less. Product shall be suitable for continuous use in low temperatures of -10º F. Manufacturers shall be Flex-Clad 400, MFM Building Products Corp. or Alumaguard 60, Polyguard Products, Inc.

B. Non-self-adhering cover: Aluminum jacketing, 0.030” thick, stucco embossed finish with moisture barrier inner lining.

2.11 EQUIPMENT INSULATION MATERIALS

A. Rigid fiberglass equipment insulation shall conform to ASTM C612, Class 2, 6.0 PCF density, K = 0.23 @ 75º F mean temperature. Cover insulation with pre-sized glass cloth jacketing

material, not less than 7.8 ounces per square yard. Provide a trowl or glove grade water based purpose mastic (white or light gray) suitable for interior or exterior applications. Install per manufacturer's written installation instructions.

B. Elastomeric Insulation: ASTM C534, Type 1, ASTM E84, NFPA 255, UL 723, K = 0.27 @ 75° F mean temperature, equal to Armaflex.

2.12 FASTENERS, MASTICS, SEALANTS, TAPES, ADHESIVES AND ACCESSORIES

A. The insulation installer shall utilize accessory materials and devices for the complete and proper application of all insulation systems, in accordance with manufacturer's directions and established good industry standards for materials and workmanship. All accessory products shall be compatible with the insulation materials being utilized.

PART 3 - EXECUTION

3.1 HVAC PIPING INSULATION

A. Provide insulation for the following piping:

Pipe Insulation Systems			
Pipe Service	Location	Insulation Type	Insulation Cover[1]
Heating & Chilled Water HR Loops & Drycoolers	Building Interior	Fiberglass	ASJ
	Exterior	Elastomeric	Metal Jacket
Make-up Water	Building Interior	Fiberglass	ASJ
	Exterior	Elastomeric	Metal Jacket
Condensate Drains	Building Interior	None	N/A
VRF Condensate Drains	Building Interior	Elastomeric	N/A
Condenser Water	Building Interior	None	N/A
	Exterior	Elastomeric	Metal Jacket
Refrigeration Piping	Building Interior	Elastomeric	None
	Exterior	Elastomeric	Paint
Heat Pump Loop	Building Interior	None	N/A
	Exterior	Elastomeric	Metal Jacket
Geothermal Heat Pump Loop	Building Interior	Fiberglass	ASJ
	Exterior	Elastomeric	Metal Jacket

NOTE: All insulated piping located in mechanical equipment rooms, platforms or other accessible spaces, located below the 10 ft level, shall be covered with PVC jacketing.

B. Provide minimum pipe insulation as listed in following table (based on 2018 Washington State Energy Code):

Pipe Service	Fluid Operating Temp, °F	Insulation Conductivity		Nominal Pipe Diameter (in.)				
		K Range BTU-in/ (hr-ft²-°F)	Mean Rating Temp. °F	1/2"- 3/4"	1"-1.25"	1.5"-3"	4"-8"	≥ 8"
				Nominal Insulation Thickness				
Steam ≥100 psig, Steam Condensate	> 350	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
Steam ≥15 psig, Steam Condensate	251-350	0.29–0.31	200	3.0	4.0	4.5	4.5	4.5
Steam <15 psig, Steam Condensate	201–250	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
Heating Water Supply / Return	141–200	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
Domestic Hot Water	≥ 105	0.24–0.28	100	1.0	1.0	1.5	1.5	1.5
Domestic Cold Water	40–60	0.23–0.27	75	0.5	0.5	1.0	1.0	1.5
Chilled Water	40–60	0.23–0.27	75	0.5	0.5	1.0	1.0	1.5
Make-Up Water	40–60	0.23–0.27	75	0.5	0.5	1.0	1.0	1.5
Condensate (VRF Indoor Units Only)	40–60	0.23–0.27	75	0.5	0.5	0.5	n/a	n/a

Heat Pump Loop	60-80	No insulation required						
Geothermal Heat Pump Loop	40–60	0.23–0.27	75	0.5	0.5	1.0	1.0	1.5
Refrigerant	40–60	0.23–0.27	75	0.5	0.5	1.0	1.0	1.5
Condenser Water	40–60	0.23–0.27	75	0.5	0.5	1.0	1.0	1.5
Direct Buried Pipe	See Section 23 21 13 - Hydronic Piping							
Dry Cooler Loop	40–60	0.23–0.27	75	0.5	0.5	1.0	1.0	1.5
Run-Around HR Loop	40–60	0.23–0.27	75	0.5	0.5	1.0	1.0	1.5

1. The Minimum Pipe Thickness chart shall be used for insulations with the scheduled 'k' values. Insulation thickness of insulation with k values outside of the schedule (i.e. calcium silicate) shall be computed via the formula noted in Washington State Energy Code.
2. For piping systems smaller than 1-1/2" and located in partitions in conditioned spaces, reductions of the listed thickness by 1 inch shall be permitted, but not less than 1 inch minimum.

C. HVAC piping system insulation omitted on steam traps on condensate piping between steam trap and union, hot piping within radiation enclosures or unit cabinets; on cold piping within unit cabinets provided piping is located over drain pan; and on unions, flanges, flexible connections, and expansion joints.

D. Insulate low temperature refrigerant piping (liquid line) with 1½" thick elastomeric insulation and cold condensate drains from refrigeration and air conditioning drain pans with 1" thick elastomeric insulation.

3.2 DUCTWORK SYSTEM INSULATION

A. Provide insulation for the following ductwork systems:

Duct Insulation Systems			
Service	Location	Insulation Type	Insulation Cover
Concealed Suspended Ductwork or Vertical Ductwork Runs	Building	Fiberglass Wrap	FSK
Exposed Ductwork Within 7'-0" of Floor Level or Areas Subject to Abuse or Maintenance Traffic	Building Mechanical Areas	Rigid Plenum Board	FSK
Ductwork run on Roof or at Exterior of Building	Exterior	Polyiso Board	Alum. Jacket
Type I Kitchen Hood (Grease) Exhaust Duct	Building	Fire Rated	FSK
	Exterior	Fire Rated	Alum. Jacket
Underground Ductwork	Below Grade	Pre-insulated FRP System (Spunstrand)	Integral
Ductwork Exposed to View in Finished Occupied Spaces	Building	Rigid Plenum Board	White PVC

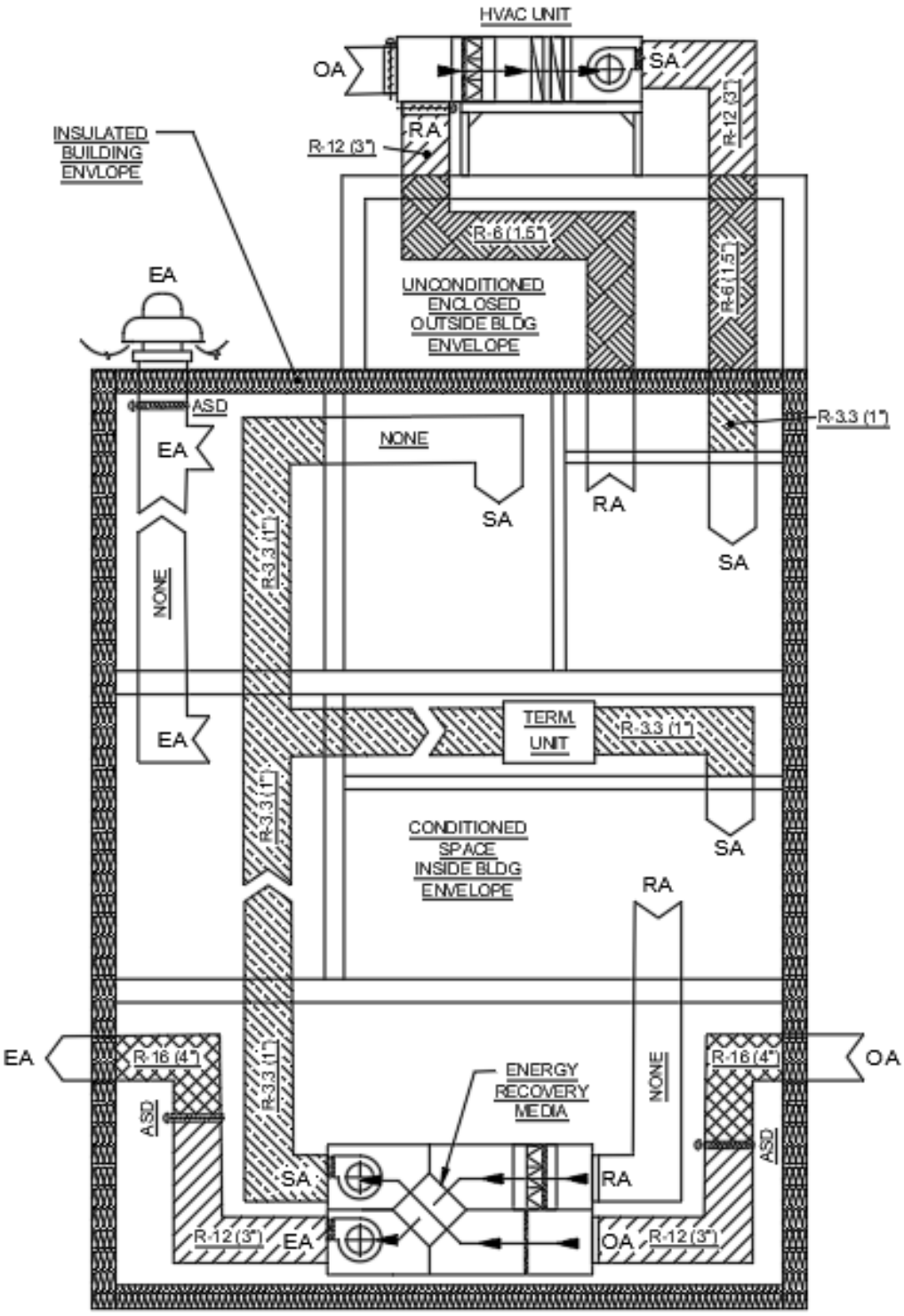
B. Definitions:

1. Conditioned Space: An area, room or space that is enclosed within the building thermal envelope and that is directly heated or cooled or that is indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ducts, piping or other sources of heating or cooling.

Minimum Duct Insulation Values (Per 2018 WA Energy Code – Climate Zone 5B)		
Duct Type	Duct Location	Insulation R- Value, (Nominal Thickness)
1. Outdoor Air	Outside the conditioned building envelope (roof, unheated attic, etc.)	None
2. Outdoor Air	Inside conditioned space, between automatic shut-off damper on/near HVAC unit and building envelope exit (louver, hood, etc.)	R-16 (4.0” wrap or board)
3. Outdoor Air	Inside conditioned space, between automatic shut-off damper and HVAC unit or room (>= 2800 CFM)	R-12 (3.0” wrap or board)
4. Outdoor Air	Inside conditioned space, between automatic shut-off damper and HVAC unit or room (<2800 CFM)	R-7 (2.0” wrap or board)
5. Supply Air	Outside the Building: On exterior of building, exposed to weather, on the roof.	R-12 (3.0” wrap or board) (2.0” polyiso)
6. Supply Air	Unconditioned space (enclosed, but not in the building conditioned space): In unconditioned attics, in enclosed unconditioned ceiling space, in ventilated garage, in ventilated crawl spaces.	R-6 (1.5” wrap or board)
7. Supply Air	Within conditioned space, but not serving same space (i.e. traversing through conditioned space), in ceiling plenums, chases, shafts, mechanical rooms and access platforms.	R-3.3 (1.0” wrap or board)
8. Supply Air	Within conditioned space, where the duct directly serves the space (is visible), and is not above a ceiling, in a shaft, etc.	None
9. Return Air	Outside the Building: On exterior of building, exposed to weather, on the roof.	R-12 (3.0” wrap or board) (2.0” polyiso)
10. Return Air	Unconditioned space (enclosed, but not in the building conditioned space): In unconditioned attics, in enclosed unconditioned ceiling space, in ventilated garage, in ventilated crawl spaces	R-6 (1.5” wrap or board)
11. Return Air	Within the conditioned space. Between the spaces served and the HVAC unit.	None
12. Exhaust Air or Relief Air	Within the conditioned space, between an energy recovery media and a downstream automatic shut-off damper.	R-12 (3.0” wrap or board)
13. Exhaust Air or Relief Air	Within the conditioned space, between the space served and the automatic shut-off damper.	None
14. Exhaust Air or Relief Air	Within the conditioned space, downstream (after) the automatic shut-off damper.	R-16 (4.0” wrap or board)
All Other Conditions	Refer to WSEC – 2018 – Table C403.10.1.2	

Duct Insulation Table Notes:

1. Duct insulation thickness values are based on typical duct insulation of K=0.25 (R=4.0/inch) (Polyiso R=5.8/inch).
2. Exposed supply and return ductwork located and visible (not in a plenum) within the space that it serves does not have to be thermally insulated unless otherwise noted on the plans.
3. Where ductwork is indicated to have internal duct liner (either field applied or factory ducts), at the Contractor’s option, the insulation value of the duct liner may be included in the above minimum values, allowing the external insulation levels to be reduced accordingly.



TYPICAL DUCTWORK INSULATION APPLICATIONS

3.3 EQUIPMENT INSULATION

A. Application Requirements: Insulate the following cold (below ambient) equipment:
   1. Refrigeration equipment, including chillers, tanks and pumps.
   2. Drip pans under chilled equipment.
   3. Cold water storage tanks.
   4. Cold and chilled water pump impeller housings.
   5. Pneumatic water tanks.
   6. Roof drain bodies.
   7. Air separators.

B. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:
   1. Elastomeric: 2” thick for refrigeration piping and devices in chilled water piping systems.

C. Application Requirements: Insulate with 2” thick rigid fiberglass the following hot (above ambient temperature) equipment:
   1. Hot water storage tanks.
   2. Heat exchangers.
   3. Condensate receivers.
   4. Hot water pumps impeller housings.
   5. Air separators.

3.4 COMMON INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation with tightly butted joints free of voids and gaps. Vapor barriers shall be continuous. Before installing jacket material, install vapor-barrier system.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

E. Install insulation with longitudinal seams at top and bottom of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials dry during application and finishing.

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Hangers and Anchors: Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
    a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

Q. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.5 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Firestopping and fire-resistive joint sealers are specified in Division 07, Section "Firestopping."

F. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies according to Division 07, Section "Firestopping."

3.6 INSTALLATION OF HOT PIPING INSULATION

A. After installation and pressure/leak testing of piping systems, install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
B. Maintain integrity of vapor barrier jacket on pipe insulation, and protect to prevent puncture or other damage.
C. Cover valves, fittings, and similar items in each piping system ≤ 2" with equivalent thickness and composition of insulation as applied to adjoining pipe run. PVC Pipe fittings shall be utilized at all fittings.
D. Install removable covers on all valves, flow balance devices, strainers, etc.
E. Extend Piping insulation without interruption through walls, floors and similar piping penetrations, except where penetrations go through fire rated construction.
F. Cover exposed ends of fiberglass with a vapor retardant mastic.
G. Butt pipe insulation against pipe hanger insulation inserts. Apply 3" wide vapor barrier tape or band over the butt joints.
H. Fasten aluminum jacket to insulation using strapping and wing seals of the same material as the cover. In exterior applications, insure that all seams are watertight. Follow manufacturer's written installation guidelines.
I. For all hot water (above ambient) hydronic heating piping, install thermal-hanger shield inserts per Section Hangers and Supports for HVAC Piping.
J. For steam piping, install thermal-hanger shield inserts or metal pipe saddles (when indicated) per Section Hangers and Supports for HVAC Piping.

3.7 INSTALLATION OF COLD PIPING INSULATION

A. After installation and leak/pressure testing is completed, install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices in ensure that insulation serves its intended purpose. Insulation must be applied so there are no voids between the inner insulation face and cold piping system. The insulation system and vapor barrier must be installed in such a manner that the piping system will not condense.
B. Maintain integrity of vapor barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Special care must be made to maintain the vapor barrier at PVC fittings and with pipe covered with aluminum jackets.
C. Cover valves, fitting and similar items in each piping system with insulation as applied to adjoining pipe run. Extra care must be taken on piping appurtenances to insure a tight fit to the adjoining fiberglass system insulation. Pump impeller housings, air separators, etc. must be totally encapsulated with insulation.
1. Install fabricated molded insulation inserts at the pipe fittings under the PVC fitting.
D. Install removable covers on all valves, flow balance devices, strainers, etc.
E. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where penetrations go through fire rated construction. At fire rated construction, stop insulation at each side of the penetration, fill the interstitial space between the fire caulk with mineral wall (or other approved material), and seal penetration to maintain fire rating.
F. Cover exposed ends of fiberglass with a vapor retardant mastic.

G. Elastomeric Insulation:
   1. Glue the butt ends of insulation to each other to form a homogenous membrane maintaining the vapor barrier.
   2. Exterior elastomeric insulation shall be installed with the longitudinal seam on the bottom of the pipe and shall be protected with an ultra violet resistive paint.

H. Butt pipe insulation against pipe hanger insulation inserts. Apply wet coat of vapor barrier lap cement on butt joints and over staples and seal joints with 3" wide vapor barrier tape or band.

I. Fasten aluminum jacket to insulation using strapping and wing seals of the same material as the cover. In exterior applications, insure that all seams are watertight. Follow manufacturer's written installation guidelines.

J. For all cold or chilled water (below ambient) hydronic piping, install thermal-hanger shield inserts per Section Hangers and Supports for HVAC Piping.

3.8 INSTALLATION OF DUCTWORK AND PLENUM INSULATION

A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves the intended purpose.

B. Maintain integrity of vapor barrier on ductwork insulation, and protect it to prevent puncture and other damage. Where punctures occur, patch tears with a tape of the same facing. Excessive damage will require the insulation to be replaced.

C. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where penetrations go through fire rate construction.

D. Protect insulation on exterior ductwork from weather by installing outdoor protective finish or jacketing as recommended by manufacturer.

3.9 INSTALLATION OF EQUIPMENT INSULATION

A. Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves the intended purpose.

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not us mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship

C. Maintain integrity of vapor barrier on equipment insulation and protect it to prevent puncture or other damage.

D. Do not apply insulation to equipment while hot.

E. Apply insulation using the staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.

F. Coat insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

G. Cover fiberglass insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2". Apply over vapor barrier where applicable.

H. Do not insulate handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.

I. Provide removable insulation sections to cover parts of equipment that must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, and accessories.

J. Protect outdoor insulation from weather by installation of weather-barrier mastic protective finish or jacketing, as recommended by the manufacturer.

3.10 FIRE RATED INSULATION SYSTEM INSTALLATION

A. When fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous UL-listed fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07.

END OF SECTION 23 07 00

SECTION 23 09 23 - CONTROLS AND INSTRUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes Control Of (but not limited to):
   1. Air Handling Units.
   2. Heat Recovery Ventilation Units.
   3. Fan Coil Units
   4. Chillers
   5. Boilers
   6. Installation, interface and wiring of Boiler Control Panel.
   7. Air Terminal Units.
   8. Unit Heaters.
   9. Pumps.
   10. Utility meter monitoring.

B. Related Sections
   1. Section 23 00 00 – General HVAC Provisions
   2. Section 23 05 00 – Basic HVAC Materials and Methods
   3. Section 23 05 93 – Testing, Adjusting and Balancing
   4. Section 23 08 00 – Mechanical Systems Commissioning
   5. Section 23 09 26 – Variable Frequency Drives
   6. Section 23 21 13 – Hydronic Piping
   7. Section 23 21 23 – Hydronic Pumps
   8. Section 23 34 23 – Power Ventilators
   9. Section 23 52 16 – Condensing Hot Water Boilers
   10. Section 23 64 26 – Air-Cooled Chillers
   11. Section 23 72 00 – Indoor Heat Recovery Ventilator Units
   12. Section 23 73 13 – Modular Air Handling Units
   13. Section 23 36 00 – Air Terminal Units
   14. Section 23 81 27 – Ductless Split System Air Conditioning Units
   15. Section 23 82 36 – Electric Heaters
   16. Division 26 - Electrical

1.2 SCOPE OF WORK

A. The Building Automation System (BAS) contractor shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with BACnet open communications capabilities as herein specified. System shall be capable of A-L BACnet communications according to ASHRAE standard SPC-135A/95.

B. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least three years.

C. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer. The installing manufacturer shall certify in writing, that the shop drawings have been prepared by the equipment manufacturer and that the equipment manufacturer has supervised their installation. In addition, the equipment manufacturer shall certify, in writing, that the shop drawings were prepared by their company and that all temperature control equipment was installed under their direct supervision.

D. BAS manufacturer shall be responsible for all BAS and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes. Refer to project electrical drawings for work to be provided and installed by Division 26 contractor.

E. ALTERNATE NO. 1A AND 1B MECHANICAL CONTROLS
1. There will be no base bid for mechanical controls. Add all material and labor required to provide the work shown on the drawings and specifications, as identified in the Contract Documents.
2. Bid Alternate #1A:
   a. Base Bid: No Controls
   b. Alternate #1A: Provide direct digital controls in accordance with Division 23 and the Contract Documents as manufactured by Alerton.
3. Bid Alternate #1BA:
   a. Base Bid: No Controls
   b. Alternate #1B: Provide direct digital controls in accordance with Division 23 and the Contract Documents as manufactured by Automated Logic.

1.3 QUALITY ASSURANCE

A. The BAS system shall be designed and installed, commissioned and serviced by factory trained personnel of the local branch office of the manufacturer or the local, manufacturer's franchised dealer. The manufacturer/dealer shall have an in-place support facility within 150 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment.

B. The manufacturer or franchised dealer shall provide an experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the BAS. Project Manager shall have satisfactorily completed designated control system manufactures factory training course. Proof of training shall be provided to include date and duration of training.

C. The control contractor shall provide evidence of at least ten successful local installations of similar size and type using the same BACnet based components to be used on this project. Proprietary or other non-BACnet systems shall not be considered for this analysis.

D. The control contractor shall have a dedicated parts and service department.

E. The control contractor shall be qualified to be directly bondable for this size of control project.

F. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements. All materials and equipment furnished shall be new.

G. All BAS peer-to-peer network controllers, central system controllers, floor level controllers, and local user displays shall be UL Listed under Standard UL 916 for Energy Management Equipment, and be so listed at the time of Bid. Control equipment and systems involving smoke control shall be listed under UL864 "Controlling Units for Fire-Protective Signaling Systems," and follow NFPA 92A "Recommended Practice for Smoke-Control Systems" and NFPA 92B "Guide for Smoke Management Systems in Malls, Atria, and Large Areas."

H. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

I. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years.

J. Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1.4 DEMONSTRATION

A. Before acceptance of the control system the contractor shall be required to demonstrate a working control system to the owner and engineer that is in full compliance with this specification.

1.5 SUBMITTALS

A. Submit shop drawings and product data to requirements of Section 23 00 00.
   1. Complete control drawings for approval. These drawings shall include wiring diagrams and a complete description of the sequence of operation for all units and systems in the building.
   2. Two complete copies of "as-constructed" control diagrams with or superimposed on 1/16" scale drawings of the building in each cabinet. These drawings shall be laminated in plastic after approval by the Owners Representative. One copy shall be posted at the main control cabinet of the building and the second copy shall be given to the Owner.
   3. Sequencing and Scheduling.
   4. Qualifications of the manufacturer's engineer shall be submitted in writing within the time frame of submittals. Manufacturer's engineer shall have five years' experience in the automation and control field.

B. Minimum requirements for submittals shall be as follows:
   1. Valve and damper schedules
   2. Equipment data cut sheets
   3. System schematics, including:
      a. Sequence of Operations
      b. Point Names
      c. Point Addresses
      d. Interface Wiring Diagrams
      e. Panel Layouts
      f. System Riser Diagrams
   4. Auto-CAD compatible as-built drawings

C. Upon project completion, submit operation and maintenance manuals, to the requirements of section 15050 and the following:
   1. Index sheet, listing contents in alphabetical order
   2. Manufacturer's equipment parts list of all functional components of the system, Auto-CAD disk of system schematics, including wiring diagrams.
   3. Description of sequence of operations.
   4. As-Built interconnection wiring diagrams.
   5. Operator's Manual
   6. Trunk cable schematic showing remote electronic panel locations, and all trunk data
   7. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.)
   8. Conduit routing diagrams

1.6 WARRANTY

A. Provide all services, materials and equipment necessary for the successful operation of the entire BAS system for a period of one year after beneficial use.

B. Complete service, as required, including but not limited to a minimum of (4) service inspections of all control systems during the first year following acceptance of the work.

C. The on-line support services shall allow the local BAS subcontractor to dial out over telephone lines to monitor and control the facility's building automation system. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays.

D. The adjustment, required testing, and repair of the system includes all computer equipment, transmission equipment and all sensors and control devices.

1.7 CONTRACTOR QUALIFICATIONS

A. The contractor shall have an office that is staffed with engineers trained in Integrating Interoperable Systems and technicians fully capable of providing BacNet instruction and routine emergency maintenance service on all system components.

B. The successful bidder shall supply a list of the experience and qualifications for the project manager who will be overseeing the installation and providing the programming.

C. Alternate 2 – Energy Management and Control System (EMCS)
   1. Base Bid: No controls.

2. Alternate 2a: Automated Logic Controls
3. Alternate 2b: Alerton Controls

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2004, BACnet.

B. Install new wiring and network devices as required to provide a complete and workable control network. Use Ethernet backbone for network segments. Refer to Electrical Drawings.

C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.

1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in temperature control drawings and specified. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

E. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.

F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

2.3 OPERATOR INTERFACE

A. Operator Interface. Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information. There shall be no limit to the number of simultaneous operators.

B. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135-2004, BACnet Annex J.

C. Hardware. The web server shall consist of the following:

1. Hardware Base. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified in Section 23 09 23. Hard disk shall have sufficient memory to store system software, one year of data for trended points specified, and a system database at least twice the size of the existing database at system acceptance. Configure computers and network connections if multiple computers are required to meet specified memory and performance. Web server or workstations shall be IBM-compatible PCs with a minimum of:

2. Intel Pentium 2.66 GHz processor
3. 1 GB RAM
4. 80 GB hard disk providing data at 100 MB/sec
5. 48x CD-ROM drive
6. Serial, parallel, and network communication ports and cables required for proper system operation
7. Portable Operator's Terminal shall be IBM-compatible laptop with a minimum of:
8. Intel 1.8 GHz processor
9. 512 GB RAM
10. 40 GB hard disk or better
11. 48x CD-ROM drive
12. Serial, parallel, and network communication ports and cables required for proper system operation

D. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
   1. Log In and Log Out. System shall require user name and password to log in to operator interface.
   2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
   3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, PID gains, on and off controls, and sensor calibration.
   4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
   5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.
   6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
   7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.
   8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
   9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

E. System Software.
   1. Operating System. Web server shall have an industry-standard professional-grade operating system. Acceptable systems include Microsoft Windows XP Pro, Red Hat Linux, or Sun Solaris.
   2. System Graphics. Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

3. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
4. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
5. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
6. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

F. System Tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.
1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
2. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
3. System Configuration. Operators shall be able to configure the system.
4. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.
5. Security. System shall require a user name and password to view, edit, add, or delete data.
    a. Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object.
    b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.
    c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
6. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).
7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
8. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
9. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
10. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.
11. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall

sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Section 15900. Trends shall be BACnet trend objects.

12. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics, or through custom programs.
13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
14. Standard Reports. Furnish the following standard system reports:
    a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
    b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
    c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
        1) Alarm History.
        2) Trend Data. Operator shall be able to select trends to be logged.
        3) Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.

G. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.

H. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.

I. Custom Application Programming. Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
    a. Language. Language shall be graphically based and shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks.
    b. Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.
    c. Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.
    d. Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.
    e. Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

f. Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
g. Variables: Operator shall be able to use variable values in program conditional statements and mathematical functions.
    4) Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
    5) System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.

2. Energy Data Collection and Reporting: System shall include an easily configured energy reporting tool that provides the capabilities described in this section.
    a. The energy reporting tool shall be accessible through the same user interface (Web browser or operator workstation software) as is used to manage the BAS.
    b. The energy reporting tool shall be preconfigured by the Contractor to gather and store energy demand and consumption data from each energy source that provides metered data to the BAS. Meter data shall be stored at 5 minute intervals unless otherwise specified in the Sequence of Operation provided in section 23 09 93. This data shall be maintained in an industry standard SQL database for a period of not less than five years.
    c. The energy reporting tool shall allow the operator to select an energy source and a time period of interest (day, week, month, year, or date range) and shall provide options to view the data in a table, line graph, bar graph, or pie chart. The tool shall also allow the operator to select two or more data sources and display a comparison of the energy used over this period in any of the listed graph formats, or to total the energy used by the selected sources and display that data in the supported formats.
    d. The energy reporting tool shall allow the operator to select an energy source and two time periods of interest (day, week, month, year, or date range) and display a graph that compares the energy use over the two time periods in any of the graph formats listed in the previous paragraph. The tool shall also allow the operator to select multiple energy sources and display a graph that compares the total energy used by these sources over the two time periods.
    e. The energy reporting tool shall allow the operator to easily generate the previously described graphs "on the fly," and shall provide an option to store the report format so the operator can select that format to regenerate the graph at a future date. The tool shall also allow the user to schedule these reports to run on a recurring basis using relative time periods, such as automatically generating a consumption report on the first Monday of each month showing consumption over the previous month. Automatically generated reports shall be archived on the server in a common industry format such as Adobe PDF or Microsoft Excel with copies e-mailed to a user editable list of recipients.
    f. The energy reporting tool shall be capable of collecting and displaying data from the following types of meters:
        6) Electricity (data from main building meter and multiple sub-meters)
        7) Natural Gas
        8) Domestic Potable Hot and Cold Water
        9) Heating and cooling degree days. (May be calculated from sensor data rather than metered.)
    g. The user shall have the option of using Kw (Kwh) or Btu/hr (Btu) as the units for demand and consumption reports. Multiples of these units (MWH, kBtu, etc.) shall be used as appropriate. All selected sources shall be automatically converted to the

selected units. The user shall similarly have the option of entering facility area and occupancy hours and creating reports that are normalized on an area basis, an annual use basis, or an occupied hour basis.

h. The user shall have the option of entering benchmark data for an individual facility or a group of facilities.

i. The user shall have the option of displaying any or all of the following data on any chart, line, or bar graph generated by the energy reporting tool:

10) Low/High/Average value of the metered value being displayed.

11) Heating and/or Cooling Degree Days for the time period(s) being displayed.

J. Portable Operator's Terminal. Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

K. BACnet. Web server or workstation shall have demonstrated interoperability during at least one BMA Interoperability Workshop and shall substantially conform to BACnet Operator Workstation (B-OWS) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L.

2.4 CONTROLLER SOFTWARE

A. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.

B. Scheduling. System shall provide the following schedule options as a minimum:

1. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
2. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
3. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.

C. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.

D. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.

E. Demand Limiting.

1. System shall monitor building power consumption from building power meter pulse generator signals or from building feeder line watt transducer or current transformer.
2. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified. When demand drops below adjustable levels, system shall restore loads as specified.

F. Maintenance Management. System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified.

G. Sequencing. Application software shall sequence chillers, boilers, and pumps as specified.

H. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

I. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

J. Energy Calculations.

1. System shall accumulate and convert instantaneous power (kW) or flow rates (gpm) to energy usage data.

2. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.

K. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.

L. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

M. Runtime Totalization. System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as indicated on the drawings.

2.5 CONTROLLERS

A. General. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.

B. BACnet.

1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
4. Smart Actuators (SAs). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.
5. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
6. BACnet Communication.
    a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
    b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
    c. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET Data Link/Physical layer protocol.
    d. Each ASC shall reside on a BACnet network using the ARCNET Data Link/Physical layer protocol.
    e. Each SA shall reside on a BACnet network using the ARCNET Data Link/Physical layer protocol.
    f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET Data Link/Physical layer protocol.

C. Communication.

1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
4. Stand-Alone Operation. Each piece of equipment specified in temperature control drawings shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -20°F to 140°F.
2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 32°F to 120°F.

E. Keypad. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

F. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.

G. Serviceability.
1. Controllers shall have diagnostic LEDs for power, communication, and processor.
2. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
3. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

H. Memory.
1. Controller memory shall support operating system, database, and programming requirements.
2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.

I. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.

J. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.6 INPUT AND OUTPUT INTERFACE

A. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.

B. Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.

C. Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.

D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.
E. Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
F. Binary Outputs. Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation. Triac outputs are not allowed.
G. Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
H. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

2.7 AUXILIARY CONTROL DEVICES

A. Motorized Control Dampers.
   1. Type. Control dampers shall have linear flow characteristics and shall be parallel- or opposed-blade type as specified below or as scheduled on drawings.
      a. Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.
      b. Other modulating dampers shall be opposed-blade.
      c. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.
   2. Frame. Damper frames shall be 13 gauge galvanized steel channel or 1/8 in. extruded aluminum with reinforced corner bracing.
   3. Blades. Damper blades shall not exceed 8 in. in width or 48 in. in length. Blades shall be suitable for medium velocity 2000 fpm performance. Blades shall be not less than 16 gauge.
   4. Shaft Bearings. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
   5. Seals. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 10 cfm per ft2 at 4 in. w.g. differential pressure. Blades shall be airfoil type suitable for wide-open face velocity of 1500 fpm.
   6. Sections. Damper sections shall not exceed 48 in. - 60 in. Each section shall have at least one damper actuator.
   7. Linkages. Dampers shall have exposed linkages.
B. Electric Damper and Valve Actuators.
   1. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
   2. Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
   3. Signal and Range. Proportional actuators shall accept a 0-10 Vdc or a 0-20 mA control signal and shall have a 2-10 Vdc or 4-20 mA operating range.
   4. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
   5. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank.
   6. All actuators shall be Belimo, no substitutions.
C. Control Valves.

1. General. Select body and trim materials in accordance with the control system manufacturer's recommendations for design conditions and service shown.
2. Type: Provide two- or three-way control valves for two-position or modulating service as shown.
3. Pressure Independent, Characterized Control Valves (PICCV): Unless otherwise noted, provide pressure independent control valves for all two-way modulating controlled coils. Pressure independent control valves shall be provided with an integral upstream pressure regulating device and a characterized control ball valve, for automatic dynamic balancing regardless of fluctuations of system pressure. Valve and actuator shall be sized for design flow rates, with pre-rotation/limitation of ball valve factory set, but field adjustable using separate commissioning tool (tool to be provided by valve manufacturer). Separate manual circuit setters installed on two-way control valve coils are to be used to field verify actual flow rates, but not used for balancing.
   a. Manufacturer: Belimo PICCV control valve and matching actuator, no substitutions.
4. Water Control Valves.
   a. Valves providing two-position service shall be quick opening. Control valves shall have replaceable disc or ball.
   b. Close-off (Differential) Pressure Rating. Valve actuator and trim shall provide the following minimum close-off pressure ratings.
      12) Two-way: 150% of total system (pump) head, minimum 50 psi.
      13) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head, minimum 50 psi.
   c. Ports. Valves providing modulating service shall have equal percentage ports.
   d. Sizing.
      14) Two-position service: line size.
      15) Two-way modulating service – pressure dependent type: select pressure drop equal to the greatest of twice the pressure drop through heat transfer device (coil or heat exhanger), 50% of the pressure difference between supply and return mains, or 5 psi.
      16) Two-way modulating service – pressure independent type: Sizing by valve manufacturer. Actuator setting to provide full valve authority with 2-10 volt control signal at reduced ball angle, with 100 second running time. Where multiple control valves are required due to flow rates that exceed single valve capability, the additional coil piping, fittings, insulation, etc. shall be provided at no additional charge to the Owner.
      17) Three-way modulating service: select pressure drop equal to the smaller of twice the pressure drop through the coil exchanger (load) or 5 psi.
   e. Fail Position. Water valves shall fail normally open or closed as follows unless otherwise specified.
      18) Heating coils: normally open.
      19) Chilled water coils: normally closed.
      20) Other applications: as scheduled or as required by sequences of operation.

D. Binary Temperature Devices.
1. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 55°F-85°F setpoint range, 2°F maximum differential, and vented ABS plastic cover.
2. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 55°F-85°F setpoint range, 2°F maximum differential, and vented ABS plastic cover.
3. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 20 ft long. Element shall sense temperature in each 1 ft section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

E. Temperature Sensors.
   1. Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
   2. Duct Sensors. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 5 ft in length per 10 ft2 of duct cross-section.
   3. Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
   4. Space Sensors. Space sensors shall not include a display, but have setpoint adjustment, override switch, and communication port. Sensors serving both Gyms shall be plate style with no local adjustments.
   5. Differential Sensors. Provide matched sensors for differential temperature measurement.

F. Humidity Sensors.
   1. Duct and room sensors shall have a sensing range of 20%-80%.
   2. Duct sensors shall have a sampling chamber.
   3. Outdoor air humidity sensors shall have a sensing range of 20%-95% RH and shall be suitable for ambient conditions of 40°F-170°F.
   4. Humidity sensors shall not drift more than 1% of full scale annually.

G. Flow Switches. Flow-proving switches shall be paddle (water service only) or differential pressure type (air or water service) as shown. Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).
   1. Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.
   2. Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

H. Relays.
   1. Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
   2. Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable ±100% from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

I. Override Timers.
   1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

J. Current Transmitters.
   1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be ±1% full-scale at 500 ohm maximum burden.
   2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
   3. Unit shall be split-core type for clamp-on installation on existing wiring.

K. Current Transformers.
   1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
   2. Transformers shall be available in various current ratios and shall be selected for ±1% accuracy at 5 A full-scale output.
   3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

L. Voltage Transmitters.
   1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.

2. Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be ±1% full-scale at 500 ohm maximum burden.
3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

M. Voltage Transformers.
1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
2. Transformers shall be suitable for ambient temperatures of 40°F-130°F and shall provide ±0.5% accuracy at 24 Vac and 5 VA load.
3. Windings (except for terminals) shall be completely enclosed with metal or plastic.

N. Power Monitors.
1. Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.
2. Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of ±2% at 1.0 power factor or ±2.5% at 0.5 power factor.

O. Current Switches.
1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

P. Wet Differential Pressure Transducers.
1. Transducers shall have linear output signal and field-adjustable zero and span.
2. Continuous operating conditions of positive or negative pressure 50% greater than calibrated span shall not damage transducer sensing elements.
3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 150 psi. Transducer shall have 4-20 mA output, suitable mounting provisions, and block and bleed valves.
4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 150 psi. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall have 4-20 mA output, suitable mounting provisions, and 5-valve manifold.

Q. Dry Differential Pressure Transducers.
1. Transducers shall have linear output signal and field-adjustable zero and span.
2. Microprocessor based transducer design with LCD readout, with selectable ranges and scales.
3. Unidirectional range 0-1.0”wg or 0-10.0” wg as required for application. Rated to 3 psid burst pressure. Accuracy +/- 1.0% of FS.
4. 4-20mA or 0-10V output signal, selectable.
5. Input power: 24VAC, 30mA max.
6. Veris PX series.

R. Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

S. Pressure-Electric (PE) Switches. PE switches shall be UL listed, pilot duty rated (125 VA minimum) or motor control rated, metal or neoprene diaphragm actuated, operating pressure rated for 0-25 psig, with calibrated scale minimum setpoint range of 2-18 psig.
1. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application.
2. Switches shall be open type (panel-mounted). Exception: Switches shall be enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.
3. Each pneumatic signal line to PE switches shall have permanent indicating gauge.

T. Local Control Panels.
1. Indoor control panels shall be fully enclosed NEMA 1 construction with hinged door key-lock latch and removable sub-panels. A common key shall open each control panel and sub-panel.

2. Prewire internal and face-mounted device connections with color-coded stranded conductors tie-wrapped or neatly installed in plastic troughs. Field connection terminals shall be UL listed for 600 V service, individually identified per control and interlock drawings, with adequate clearance for field wiring.
3. Each local panel shall have a control power source power switch (on-off) with overcurrent protection.

U. CO2 Sensors: Provide an electronic sensor to monitor amount of Carbon Dioxide (CO2) suitable for duct mounting. Measuring principal shall be based on infrared spectroscopy. Internal electronics shall require a 24 vac power supply and shall calculate CO2 concentration in return air and output a linearized actual value of 0-5 vdc to DDC panel for use in optimization of mixing dampers and economizer control. Manufacturers shall be Airtest, Veris or approved equivalent.

V. Water Flow Measuring Devices: Provide an electronic water flow measuring device where indicated on the hydronic flow diagrams. Internal electronics shall require a 24 vac power supply. Water flow measuring device shall be Onicon Model F-1200 series dual turbine meter with local readout display module and output signal to EMCS.

W. Airflow Measuring Stations: Duct mounted air flow measuring stations provided and installed under Section 23 33 00. Fan air flow measuring stations are to be provided with air handling equipment. Coordinate for proper EMCS interface and I/O signal requirements.

X. Variable Frequency Drives: Variable Frequency Drives (VFDs) shall be provide under Section 23 09 26 and factory installed on air handling equipment, or field installed and wiring by Division 26. Coordinate interface and control wiring I/O requirements with EMCS.

2.8 CONTROL POWER TRANSFORMERS

A. Provide all low voltage power supplies and transformers in sufficient quantity and distribution, to provide power to all control devices. 24 VAC power supply to all control devices shall be Class II as defined by NEC.

B. Transformer size for any load shall be 100 VA maximum, 40 VA minimum. Provide with integral circuit breaker protection.

2.9 WIRING AND RACEWAYS

A. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.

B. Insulated wire shall use copper conductors and shall be UL listed for 200°F minimum service.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Architect or Engineer for resolution before starting rough-in work.

B. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.

C. Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Engineer and obtain written instructions for changes necessary to accommodate Section 23 09 23 work with work of others. Controls Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

3.2 PROTECTION

A. Controls Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.

B. Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

A. Site.
   1. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
   2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

B. Test and Balance.
   1. Provide Test and Balance Contractor a single set of necessary tools to interface to control system for testing and balancing excluding laptop computer.
   2. Train Test and Balance Contractor to use control system interface tools.
   3. Provide a qualified technician to assist with testing and balancing in getting started with testing.
   4. Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.

C. Life Safety.
   1. Duct smoke detectors required for air handler shutdown are provided under Division 28. Interlock of smoke detectors to air handlers for shutdown is by Division 28. Coordinate with Division 28 for locations.
   2. Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 23. Fire and smoke damper control is provided under Division 28.

D. Coordination with Other Network Based Controls.
   1. Integrate with and coordinate network-based controls (BACnet, Lonwork, Modbus) and control devices furnished or installed by others including the following.
      a. Boilers.
      b. Chiller.
      c. Variable Frequency Drives.
      d. Power System Monitoring.
   2. Communication media and equipment shall be provided as specified in Section 23 09 23 (Communication).
   3. Each supplier of a controls product shall configure, program, start up, and test that product to meet the sequences of operation described on the drawings, regardless of where within the contract documents those products are described.
   4. Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
   5. Controls Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.
   6. Controls Contractor shall map networked data points from controllers to the central Operator's Workstation and shall develop graphics and display of values for data points available from networked devices. Allow for a minimum of 20 data points to be mapped from each networked device unless noted otherwise. Selection of available data points for display shall be determined by Owner and Engineer during shop drawing development.

3.4 LOCATIONS

A. BAS front end computer and interface to be located in upper level Mechanical Room #204.

3.5 GENERAL WORKMANSHIP

A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.

B. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.

C. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.
D. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.
E. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.6 FIELD QUALITY CONTROL

A. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 23 09 23 (Codes and Standards).
B. Continually monitor field installation for code compliance and workmanship quality.
C. Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

3.7 WIRING

A. Provide all control wiring and raceways for a complete and fully operation system under this Section, including line voltage power supply to controllers and transformers, low voltage power supplies to field devices, actuators, switches, sensors and controllers, and all hard-wired I/O wiring and all communications wiring and/or cabling. Coordinate with Division 26 for available power source supply circuits.
B. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26, and manufacturer's recommendations. Where the requirements of Section 23 09 23 differ from Division 26, Section 23 09 23 shall take precedence.
C. NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC and Division 26.
D. Low-voltage wiring shall meet NEC Class 2 requirements. Subfuse low-voltage power circuits as required to meet Class 2 current limit.
E. NEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.
F. Install wiring in raceway where subject to mechanical damage and at levels below 7 ft in mechanical, catwalk platform areas, electrical, or service rooms.
G. Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.
H. Do not install wiring in raceway containing tubing.
I. Run exposed Class 2 wiring parallel to a surface or perpendicular to it and tie neatly at 3 m (10 ft) intervals.
J. Use structural members to support or anchor plenum cables without raceway. Do not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.
K. Secure raceways with raceway clamps fastened to structure and spaced according to code requirements.
L. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.
M. Size raceway and select wire size and type in accordance with manufacturer's recommendations and NEC requirements.
N. Include one pull string in each raceway 1 in. or larger.
O. Use color-coded conductors throughout.
P. Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.
Q. Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 6 in. between raceway and high-temperature equipment such as steam pipes or flues.
R. Adhere to requirements in Division 26 where raceway crosses building expansion joints.
S. Install insulated bushings on raceway ends and enclosure openings. Seal top ends of vertical raceways.

T. Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.
U. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including chiller and boiler rooms.
V. Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.

3.8 COMMUNICATION WIRING

A. Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article (Wiring).
B. Install communication wiring in separate raceways and enclosures from other Class 2 wiring. Communications wiring can be ran as open plenum cable in accessible areas.
C. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.
D. Verify entire network's integrity following cable installation using appropriate tests for each cable.
E. Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.
F. Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.
G. Label communication wiring to indicate origination and destination.

3.9 INSTALLATION OF SENSORS

A. Install sensors according to manufacturer's recommendations.
B. Mount sensors rigidly and adequately for operating environment.
C. Install room temperature sensors on concealed junction boxes properly supported by wall framing. For concealed sensor subject to damage, mount sensor inside junction box with vented stainless-steel cover plate, or provide tamper-proof assembly/enclosure.
D. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.
E. Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.
F. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 1 ft of sensing element for each 1 ft2 of coil area.
G. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
H. Install outdoor air temperature sensors on north wall at designated location with sun shield.
I. Differential Air Static Pressure.
    1. Supply Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
    2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
    3. Building Static Pressure. Pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover.
    4. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.
    5. Pressure transducers, except those controlling ventilation air valve boxes, shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.
    6. Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.

J. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

3.10 CO2 SENSORS

A. Mount duct mounted CO2 Sensors per manufacturer's instructions. Locate in accessible locations for maintenance or recalibration.

B. Provide CO2 Sensors in the return ductwork of the following:
   1. AHU-1
   2. AHU-2

C. Provide CO2 sensors next to the thermostat for all fan coil units except FC-41.

3.11 WATER FLOW METER

A. Provide correct size meter for pipe diameter, pipe material and thickness and application. Install in accordance with manufacturer's directions, provide thread-o-let and ball valve for removable and service under pressure capability. Mount in accessible location. Provide power and control signal wiring. Install remote read-out meter on wall or structure near insertion meter and label for service being measured. Where available, calibrate flow readings to match adjacent venturi or calibrated orifice flow device.

3.12 AIR FLOW MEASURING STATIONS

A. Installation in Section 23 33 00. Coordinate location of air flow station and remote read display in accessible location. Provide power and control signal wiring.

3.13 ACTUATORS

A. General. Mount actuators and adapters according to manufacturer's recommendations.

B. Electric and Electronic Damper Actuators. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer's recommendations.
   1. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
   2. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, then tighten linkage.
   3. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
   4. Provide necessary mounting hardware and linkages for actuator installation.

C. Valve Actuators. Connect actuators to valves with adapters approved by actuator manufacturer. Where pressure independent, characterized control valves are allowed and utilized, provide actuators with pre-rotated and pre-programmed actuator to set flow rate to design value.

3.14 WARNING LABELS

A. Affix permanent warning labels to equipment that can be automatically started by the control system.
   1. Labels shall use white lettering (12-point type or larger) on a red background.
   2. Warning labels shall read as follows:

C A U T I O N
This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

B. Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
   1. Labels shall use white lettering (12-point type or larger) on a red background.
   2. Warning labels shall read as follows:

C A U T I O N
This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.15 INDENTIFICATION OF HARDWARE AND WIRING

A. Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 2 in. of termination.
B. Label pneumatic tubing at each end within 2 in. of termination with a descriptive identifier.
C. Permanently label or code each point of field terminal strips to show instrument or item served.
D. Label control panels with minimum ½ in. letters on laminated plastic nameplates.
E. Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement.
F. Label room sensors related to terminal boxes or valves with nameplates.
G. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
H. Label identifiers shall match record documents.

3.16 PROGRAMMING

A. Point Naming. Name points as shown on the equipment points list provided with each sequence of operation. If character limitations or space restrictions make it advisable to shorten the name. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
B. Software Programming. Programming shall provide actions for each possible situation. Graphic- or parameter-based programs shall be documented. Text-based programs shall be modular, structured, and commented to clearly describe each section of the program.
    1. Application Programming. Provide application programming that adheres to sequences of operation specified. Program documentation or comment statements shall reflect language used in sequences of operation.
    2. System Programming. Provide system programming necessary for system operation.
C. Operator Interface.
    1. Standard Graphics. Provide graphics as specified. Show on each equipment graphic input and output points and relevant calculated points such as indicated on the applicable Points List as indicated on the drawings. Point information on graphics shall dynamically update.
    2. Install, initialize, start up, and troubleshoot operator interface software and functions (including operating system software, operator interface database, and third-party software installation and integration required for successful operator interface operation) as described in Section 23 09 23.

3.17 CONTROL SYSTEM CHECKOUT AND TESTING

A. Startup Testing. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any or all startup testing.
    1. Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 23 09 23.
    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 interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

3.18 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in (Control System Checkout and Testing). Provide Engineer with log documenting completion of startup tests.
    1. Engineer may be present to observe and review system demonstration. Notify Engineer at least 10 days before system demonstration begins.
    2. Demonstration shall follow process submitted and approved under. Complete approved checklists and forms for each system as part of system demonstration.
    3. Demonstrate actual field operation of each sequence of operation as specified. Provide at least two persons equipped with two-way communication. Demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation.
    4. Demonstrate compliance with sequences of operation through each operational mode.
    5. Demonstrate complete operation of operator interface.
    6. Demonstrate each of the following:
        a. DDC loop response. Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Engineer will require further tuning of each loop that displays unreasonably under- or over-damped control.
        b. Demand limiting. Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand-limiting setpoint, and status of setpoints and other affected equipment parameters.
        c. Building fire alarm system interface.
        d. Trend logs for each system. Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 10 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs as specified in Section 23 09 23 (Trend Configuration).
    7. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

B. Acceptance.
    1. After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be

performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.

2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in Section 23 09 23 (Submittals).

3.19 SEQUENCE OF OPERATION

A. See control diagrams on the drawings for devices controlled and installed under this section.

B. See control diagrams on the drawings for required sequence of operations.

C. Coordinate with Owner for determining occupancy schedules (dates and times), holidays, and desired default setpoints and alarm points. Set limits on room setpoint ranges or lockouts on designated rooms as directed by the Owner.

D. See section 11 40 00 for additional monitoring points associated with the kitchen equipment.

3.20 TRENDING

A. Provide trending for all terminal equipment and central AHUs as follows (coordinate with Owner during programming & training):

1. Supply air temperature
2. Supply and/or Exhaust air flow volume (on variable flow units)
3. Outside ventilation air flow volume
4. Space temperature

B. Provide trending for all central plant equipment follows (coordinate with Owner during programming & training):

1. Outside air temperature
2. Heating water return temperature
3. Heating water supply temperature
4. Chilled water return temperature
5. Chilled water supply temperature
6. Heating water flow rate
7. Chilled water flow rate

3.21 ADDITIONAL ALARMS

A. The following critical alarm points shall be provided and available as an “alarm pager” to designated Owner’s maintenance staff smart phones via web browser software.

1. Heating loop temperature out of range
2. Cooling loop temperature out of range
3. Boiler failure
4. Chiller failure
5. Kitchen freezer(s) high temp alarm
6. Kitchen cooler(s) high temp alarm
7. Kitchen refrigeration plant alarm
8. MDF room high temp alarm (multiple rooms-see floor plans)

B. The alarm pager shall be programmed under this contract to call the facility’s staff when an emergency condition exists. Coordinate alarm temperature setpoints with owner.

3.22 TRAINING

A. The manufacturer shall provide factory trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The manufacturer shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 am to 4:30 PM weekdays.

B. Provide 24 hours of training for Owner's designated operating personnel. Training shall include:

1. Explanation of drawings, operations and maintenance manuals
2. Walk-through of the job to locate control components
3. Operator workstation and peripherals
4. DDC controller and ASC operation/function
5. Operator control functions including graphic generation and field panel programming

6. Operation of portable operator's terminal
7. Explanation of adjustment, calibration and replacement procedures
8. Student binder with training modules
    a. System log-on procedures
    b. Review of sequence of operations
    c. System troubleshooting
    d. Emergency service interface
    e. Fire alarm interface
    f. System restart after power failure
    g. System backup and restoration procedures
    h. Replacement procedures of each system component
    i. Calibration and initialization procedures
    j. Operation of maintenance service programs

C. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Manufacturer. If such training is required by the Owner, it will be contracted at a later date.

3.23 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 09 23

SECTION 23 09 26 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SUMMARY
- A. Related Sections:
  1. Section 23 00 00 – General Provisions.
  2. Section 23 21 23 – Hydronic Pumps
  3. Section 23 73 13 – Air Handling Units
  4. Section 23 72 00 – Indoor Heat Recovery Ventilation Units
  5. Section 23 09 23 – Controls and Instrumentation.

1.2 QUALITY ASSURANCE:
- A. The adjustable frequency drives and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of IEC, UL, CUL, and NEMA.
- B. The supplier of the assembly shall be the manufacturer of the electromechanical power components used within the assembly, such as bypass contactors when specified.
- C. For the equipment specified herein, the manufacturer shall be ISO 9001certified.
- D. Variable Frequency Drives shall be on the basis of ABB ACH Series for function and quality. Products that are in compliance with the specification and manufactured by others will be considered as “Approved Equal” only if pre-approved by the Engineer fourteen (14) days prior to bid date. Alternate suppliers shall submit documentation showing itemized compliance to the specifications and experience specific to the proposed VFD including a list showing details of the installation, application, location, contact name and telephone number of at least 10 users.

1.3 SUBMITTALS:
- A. Submit shop drawings and product data per the requirements of Section 15000.
- B. The following information shall be submitted to the Engineer.
  1. Dimensioned outline drawing.
  2. Schematic diagram.
  3. Power and control connection diagram(s).

1.4 OPERATION AND MAINTENANCE DATA
- A. Submit operation and maintenance data per the requirements of Section 15000.
- B. Include manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.5 DELIVERY, STORAGE AND HANDLING
- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.6 WARRANTY
- A. Provide two years (24 months) warranty under the provisions of Section 23 00 00. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 MANUFACTURES
- A. ABB
- B. Dan Foss

2.2 VARIABLE FREQUENCY DRIVES

A. Where indicated in the drawings and specifications, adjustable frequency drives shall have the following features:

1. The VFDs shall be rated for 480 Vac. The VFD shall provide microprocessor based control for three-phase induction motors. The controller's full load output current rating shall be based on variable torque application at 40° C ambient and 10 kHz switching frequency below 40 Hp and 3.6 kHz 40 Hp and above to reduce motor noise and avoid increased motor losses.
2. The VFDs shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Adjustable Current Source VFDs are not acceptable. Insulated Gate Bipolar Transistors (IGBTs) shall be used in the inverter section. Bipolar Junction Transistors, GTOs or SCRs are not acceptable. The VFDs shall run at the above listed switching frequencies.
3. The VFDs shall have an efficiency at full load and speed that exceeds 95% for VFDs below 15 Hp and 97% for drives 15 Hp and above. The efficiency shall exceed 90% at 50% speed and load.
4. The VFDs shall maintain the line side displacement power factor at no less than 0.96, regardless of speed and load.
5. The VFDs shall have a one (1) minute overload current rating of 110% for variable torque applications.
6. The VFDs shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.
7. The VFDs shall limit harmonic distortion reflected onto the utility system to a voltage and current level as defined by IEEE 519 for general systems applications, by utilizing the standard 3% nominal impedance integral ac three-phase line reactor.
8. Any harmonic calculations shall be done based on the kVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, as noted on the drawings, and the total system load. The calculations shall be made with the point of common coupling being the point where the utility feeds multiple customers.
9. Total harmonic distortion shall be calculated under worst case conditions in accordance with the procedure outlined in IEEE standard 519-1992. Copies of these calculations are to be made available upon request. The contractor shall provide any needed information to the VFD supplier three (3) weeks prior to requiring harmonic calculations.
10. The system containing the VFDs shall comply with the 5% level of total harmonic distortion of line voltage and the line current limits as defined in IEEE 519-1992. If the system cannot meet the harmonic levels with the VFDs provided with the standard input line reactor or optional input isolation transformer, the VFD manufacturer shall supply an eighteen pulse, multiple bridge rectifier ac to dc conversion section with phase shifting transformer for all drives above 75 Hp. This eighteen pulse rectifier converter shall result in a multiple pulse current waveform that will more nearly approximate a true sinewave to reduce voltage harmonic content on the utility line. The phase shifting transformer shall be of a single winding type to optimize its KVA rating and harmonic cancellation capability.
11. Harmonic filters are not acceptable above 75 Hp.
12. The VFDs shall be able to start into a spinning motor. The VFDs shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFDs shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
13. Standard operating conditions shall be:
    a. Incoming Power: Three-phase, 480 Vac (+10% to -15%) and 50/60 Hz (+/-5 Hz) power to a fixed potential DC bus level.
    b. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
    c. Speed regulation of +/- 0.5% of base speed.
    d. Load inertia dependant carryover (ridethrough) during utility loss.
    e. Insensitive to input line rotation.

f. Humidity: 0 to 95% (non-condensing and non-corrosive).
g. Altitude: 0 to 3,300 feet (1000 meters) above sea level.
h. Ambient Temperature: -10 to 40 °C (VT).
i. Storage Temperature: -40 to 60 °C.

14. Control Functions:
    a. Frequently accessed VFD programmable parameters shall be adjustable from a digital operator keypad located on the front of the VFD. The VFDs shall have a 3 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not acceptable, and particularly those that use alphanumeric code and tables. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.
    b. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer's RS-232 port and Windows™ based software. In addition the software shall permit control and monitoring via the VFD's RS232 port. The manufacturer shall supply a diskette with the required software. An easily understood instruction manual and software help screens shall also be provided. The computer software shall be used for modifying the drive setup and reviewing diagnostic and trend information as outlined in this section through section 18.
    c. The operator shall be able to scroll through the keypad menu to choose between the following:
        1) Monitor
        2) Operate
        3) Parameter setup
        4) Actual parameter values
        5) Active faults
        6) Fault history
        7) LCD contrast adjustment
        8) Information to indicate the standard software and optional features software loaded.
    d. The following setups and adjustments, at a minimum, are to be available:
        1) Start command from keypad, remote or communications port
        2) Speed command from keypad, remote or communications port
        3) Motor direction selection
        4) Maximum and minimum speed limits
        5) Acceleration and deceleration times, two settable ranges
        6) Critical (skip) frequency avoidance
        7) Torque limit
        8) Multiple attempt restart function
        9) Multiple preset speeds adjustment
        10) Catch a spinning motor start or normal start selection
        11) Programmable analog output
        12) Proportional/Integral process controller
    e. The VFDs shall have the following system interfaces:
        1) Inputs – A minimum of six (6) programmable digital inputs, two (2) analog inputs and serial communications interface shall be provided with the following available as a minimum:
            (a) Remote manual/auto
            (b) Remote start/stop
            (c) Remote forward/reverse
            (d) Remote preset speeds
            (e) Remote external trip
            (f) Remote fault reset
            (g) Process control speed reference interface, 4-20mAdc
            (h) Potentiometer or process control speed reference interface, 1-10Vdc
            (i) RS232 programming and operation interface port

2) Outputs – A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output, and one (1) programmable analog output shall be provided, with the following available at minimum.
3) Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following available at minimum:
   (a) Fault
   (b) Run
   (c) Ready
   (d) Reversing
   (e) Jogging
   (f) At speed
   (g) In torque limit
   (h) Motor rotation direction opposite of commanded
   (i) Overtemperature
4) Programmable open collector output with available 24Vdc power supply and selectable with the following available at minimum:
   (a) Fault
   (b) Run
   (c) Ready
   (d) Reversing
   (e) Jogging
   (f) At speed
   (g) In torque limit
   (h) Motor rotation direction opposite of commanded
   (i) Overtemperature
5) Programmable analog output signal, selectable with the following available at minimum:
   (a) Output current
   (b) Output frequency
   (c) Motor speed
   (d) Motor torque
   (e) Motor power
   (f) Motor voltage
   (g) DC link voltage
   (h) Monitoring and Displays

f. The VFD's display shall be a LCD type capable of displaying three (3) lines of text and the following thirteen (13) status indicators:
   1) Run
   2) Forward
   3) Reverse
   4) Stop
   5) Ready
   6) Alarm
   7) Fault
   8) Local
   9) Panel
   10) Remote
   11) Hand
   12) Auto
   13) Off

g. The VFD's keypad shall be capable of displaying the following monitoring functions at a minimum:
   1) Output frequency
   2) Output speed
   3) Motor current
   4) Motor torque

5) Motor power
6) Motor voltage
7) DC-link voltage
8) Heatsink temperature
9) Total operating days counter
10) Operating hours (resetable)
11) Total megawatt hours
12) Megawatt hours (resetable)
13) Voltage level of analog input
14) Current level of analog input
15) Digital inputs status
16) Digital and relay outputs status
17) Motor temperature rise, percentage of allowable.

15. Protective Functions:
    a. The VFD shall include the following protective features at minimum:
        1) Overcurrent/Overvoltage
        2) Inverter fault
        3) Undervoltage
        4) Phase loss
        5) Output phase loss
        6) Undertemperature
        7) Overtemperature
        8) Motor stalled
        9) Motor overtemperature
        10) Motor under load Logic voltage failure
        11) Microprocessor failure
        12) DC injection braking
16. The VFD shall provide ground fault protection during power-up, starting, and running. VFD's with no ground fault protection during running are not acceptable.
17. Diagnostic Features
    a. Fault History.
    b. Record and log faults
    c. Indicate the most recent first, and store up to 9 faults.
18. Optional features to be included in the VFD:
    a. HMCP or thermal magnetic breaker to provide a disconnect means. Operating handle shall protrude the door. The disconnect shall not be mounted on the door. The handle position shall indicate ON, OFF, and TRIPPED condition. The handle shall have provisions for padlocking in the OFF position with at least three (3) padlocks. Interlocks shall prevent unauthorized opening or closing of the VFD door with the disconnect handle in the ON position. This shall be defeatable by maintenance personnel.
    b. Three contactor bypass shall include a drive input disconnect, an VFD input isolation contactor, bypass contactor and an VFD output contactor that is electrically and mechanically interlocked with the bypass contactor. This circuit shall include control logic, status lights and motor overcurrent relays. The complete bypass system (Inverter-Off-Bypass)1 (Hand-Off-Auto with Inverter-Bypass) 1 selector switch(s), and inverter/bypass pilot lights shall be packaged with the VFD. The unit may be set up for (Manual) 1 (Automatic) 1 bypass operation upon an VFD trip.
    c. Communication card for interface with ANSI/ASHRAE standard 135 (including all current addenda) bacnet using MST protocol.
19. Enclosure
    a. The VFD enclosure shall be NEMA 1. The VFD shall have complete front accessibility with easily removable assemblies.
    b. The VFD manufacturer shall maintain, as part of a national network, engineering service facilities within 250 miles of project to provide start-up service, emergency

service calls, repair work, service contracts, maintenance and training of customer personnel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Variable frequency drives shall be provided by the Division 23 contractor. VFD shall be field mounted by Division 26 or by the HRU manufacturer as noted below . Power wiring & connections from the electrical service to the VFD and from the VFD to the pumps/fans shall be field provided by division 26. Control wiring & connections between DDC controller and VFD shall be field provided by section 23 09 23 contractor.

B. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards:
   1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
   2. All final assemblies shall be tested at full load with application of line-to-line and line-to-ground bolted faults. The Variable Frequency Drive shall trip electronically without device failure.
   3. After all tests have been performed, each VFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.
   4. After the burn-in cycle is complete, each VFD shall be put through a motor load test before inspection and shipping.
   5. The manufacturer shall provide three (3) certified copies of factory test reports.

3.2 FIELD QUALITY CONTROL

A. Provide the services of a qualified manufacturer's employed Field Service Engineer or authorized service representative to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of VFD’s on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer’s installation instructions, wiring, application dependant adjustments, and verification of proper VFD operation.

B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.

C. Inspection and final adjustments.

D. Operational and functional checks of VFDs and spare parts.

E. The contractor shall certify that he has read the drive manufacturer’s installation instructions and has installed the VFD in accordance with those instructions.

F. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made

3.3 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 09 26

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials and joining methods for the following:
   1. Hot-water heating piping.
   2. Chilled-water piping.
   3. Heat Pump Loop piping.
   4. Condenser water piping
   5. Pre-Insulated Underground Piping Systems
   6. Make-up water piping
   7. Condensate-drain piping.

B. Related Sections include the following:
   1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
   2. Division 23 Section “General Duty Valves for HVAC Piping.” for hydronic valves.
      a. Valves and Pipe line specialties available from Grooved-end or pressure seal manufacturers are not allowed as substitutions for specified valves.
   3. Division 23 Section “Hydronic Piping Specialties” for air control devices, special duty valves, and other hydronic specialties.
      a. Valves and Pipe line specialties available from Grooved-end or pressure seal manufacturers are not allowed as substitutions for specified valves.
   4. Division 23 Section “Pipe Expansion Fittings and Loops” for flexible pipe connectors and expansion fittings.
   5. Division 23 Section “HVAC Water Treatment” for accessories related to chemical water treatment and controls.

1.2 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
   1. Hot-Water Heating and/or Heat Pump Piping: 125 psig at 200 deg F.
   2. Chilled-Water Piping: 125 psig at 200 deg F.
   3. Condenser-Water Piping: 125 psig at 200 deg F.
   4. Pre-Insulated Piping Systems: 125 psig at 200 deg F.
   5. Make-up Water Piping: 80 psig at 150 deg. F
   6. Condensate Drain Piping: 150 deg.F
   7. Safety-Valve-Inlet and Outlet Piping: Equal to the pressure of the piping system to which it is attached.

B. Reference Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. ASME Boiler and Pressure Vessel Code: Section IX, Welding and Brazing Qualifications.
      b. ASME B1.20 – Pipe Threads, General Purpose, Inch.
      c. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
      d. ASME B31 Series, Code for Pressure Piping.
   2. ASTM International:
      a. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      b. ASTM B32 – Standard Specification for Solder Metal
      c. ASTM B813 – Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
      d. ASTM B828 – Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

e. ASTM D1785 – Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.
f. ASTM D2564 – Standard Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Piping Systems.
g. ASTM F493 – Standard Specification for Solvent Cements for Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe and Fittings.
h. ASTM F656 – Standard Specification for Primers for Use in Solvent Cement Joints of Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.

3. American Welding Society (AWS):
   a. AWS A5.8 – Specification for Filler Metals for Brazing and Braze Welding.
   b. AWS D1.1 – Structural Welding Code – Steel.
   c. AWS D10.12 - Guide for Welding Mild Steel Pipe.
4. Copper Development Association (CDA):
   a. Copper Tube Handbook.

1.3 SUBMITTALS

A. Product Data: For each type of the following:
   1. Copper and Steel Pipe and Fittings.
   2. Pressure-seal fittings (if used).
   3. Grooved-end Copper and Steel Pipe and Fittings (if used).
   4. Pre-Insulated pipe and fittings.
B. Welding Certificates.
C. Field quality-control test reports.
D. Qualification Data: Installer certificates for grooved or pressure sealed piping.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
B. Installer Qualifications:
   1. Installers of Pressure-Sealed and Grooved-end Joints: Installers shall be certified by the joint manufacturer as having been trained and qualified to join piping with the specified pipe couplings and fittings.
   2. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, “Welding and Brazing Qualifications.”
      a. Comply with provisions in ASME B31 Series, “Code for Pressure Piping.”
      b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
C. Wrought-Copper Fittings: ASME B16.22.
D. Wrought-Copper Unions: ASME B16.22.
E. Copper or Brass Pressure Seal Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Viega - ProPress
      b. Nibco
      c. Grinnell
   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.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53, black steel, Type E or S, Grade B, with plain ends and wall thickness as indicated in Part 3 "Piping Applications" Article.
B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.
D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; flat face, and bolt holes as indicated in Part 3 "Piping Applications" Article..
F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5 and A-105 including bolts, nuts, and gaskets of the following end connections, and facings:
   1. End Connections: Socket weld or weld-neck.
   2. Facings: Raised face or flat face, to suite application (temperature and pressure) and/or equipment connection facing (do not mix facing types).
H. Steel Pressure Seal Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Viega - MegaPress
   2. Housing: Steel with "Smart Connect" feature (leakage path) to indicate unpressed connections.
   3. Sealing Element O-Rings: EPDM with 304 stainless steel separator ring and a 420 stainless steel grip ring.
   4. Tools: Manufacturer's special tools.
   5. Minimum 200-psig working pressure rating at 250 deg. F.

2.3 STAINLESS STEEL PIPE AND FITTINGS

A. Stainless Steel Piping
   1. Stainless Steel Pipe 2" and smaller – ASTM A312, 304 stainless steel pipe, Schedule 40 with threaded fittings.
   2. Stainless Steel Pipe 2" and smaller – ASTM A712, 304 stainless steel pipe, Schedule 10, [grooved joint mechanical fittings] [pressure sealed joints].
   3. Stainless Steel Pipe 2 ½" and larger – ASTM A312, 304 stainless steel pipe, Schedule 10, [grooved joint mechanical fittings] [pressure-sealed joints].
B. Stainless Steel Pressure-Seal Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Viega
      b. Victaulic
      c. Grinnell
   2. Housing: Steel
   3. O-Rings and Pipe Stops: EPDM
   4. Tools: Manufacturer's special tools.
   5. Minimum 300-psig working pressure rating at 230 deg. F.

2.4 PLASTIC PIPE FITTING:

A. ASTM D1785, Schedule 40 PVC solid wall pipe.
B. ASTM D2665, socket joints. Solvent weld socket joints with NSF cement and purple primer of type and viscosity appropriate for weather conditions and size of pipe.

2.5 JOINING MATERIALS

A. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless otherwise indicated. Gasket materials shall be suitable for pressure, temperature and fluids being used. Garlock Stress Saver or Blue-Gard series or equal. Do NOT use Red Rubber Gaskets.
   1. Full-face Type Gasket: For flat-face, Class 125 cast iron, cast-bronze or PVC flanges
   2. Narrow-face (Ring) Type Gasket: For raised-face, Class 150 and above, steel flanges.
C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
E. Brazing Filler Metals: AWS A5.8, BCuP Series with minimum 15% silver filler, copper-phosphorus alloy for joining copper with copper, or BAg1 silver alloy for joining copper with bronze or steel.
F. Welding Filler Metals: Comply with AWS D10.12.
G. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
H. Solvent Cements for Joining Plastic Piping:
   1. CPVC Piping: ASTM F493.
   2. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
I. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.6 DIELECTRIC FITTINGS
A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Capitol Manufacturing Company.
   2. Central Plastics Company.
   3. Hart Industries International, Inc.
   4. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   5. Zurn Plumbing Products Group; AquaSpec Commercial Products Division
B. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
C. Insulating Material: Suitable for system fluid, pressure, and temperature.
D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 or 300-psig minimum working pressure as required to suit system pressures.
F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.7 PRE-INSULATED UNDERGROUND CHILLED WATER PIPING
A. Pre-Insulated underground chilled water piping shall be high density polyethylene (HDPE) carrier pipe, with rigid polyurethane foam insulation, and HDPE jacketing.
B. Carrier pipe shall be HDPE, SDR 11, pressure rated to 160 psi. All fittings shall be injection molded HDPE and shall have the same thickness and pressure rating as the piping.
C. Insulation shall be rigid polyurethane foam, per ASTM C-591, with a minimum density of 2.0 lbs per cubic foot, 90%-95% closed cell content, and an initial thermal conductivity of K=0.16. Minimum thickness for 6” carrier pipe shall be 1.73 inches.
D. Outer protective casing jacket shall be HDPE, SDR 32.5. PVC or thin wall poly jackets not allowed.
E. Field joints shall be thermal butt fusion welded.
F. Pre-Insulated underground piping system shall be equal to Quik-Therm as manufactured by Perma-Pipe or equal as manufactured by Thermacor.

PART 3 EXECUTION

4.1 PIPING APPLICATIONS

A. Hot-water heating, Chilled water, condenser water and heat pump loop piping, aboveground, NPS 2” and smaller, shall be one of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
   2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
   3. Type L, drawn-temper copper tubing, with wrought copper or brass pressure seal fitting.

B. Hot-water heating, Chilled water, condenser water and heat pump loop piping, aboveground, NPS 2-1/2” and larger, shall be one of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
   2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   3. Type L, drawn-temper copper tubing, with wrought copper or brass pressure seal fittings.

C. Chilled-water piping, underground, NPS 1-1/2” and larger, shall be the following:
   1. Pre-Insulated HDPE piping system with butt fusion welded joints and fittings.

D. Makeup-water piping installed aboveground shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

E. Cold Condensate-Drain Piping:
   1. Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

F. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

4.2 PIPING INSTALLATIONS

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

B. Install piping in concealed locations, unless otherwise indicated except in equipment rooms and service areas. Pipe routed inside exterior walls shall be installed on the warm side of the insulation.

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

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Reduce pipe sizes where required using eccentric reducer fitting installed with level side up. Reducers are not indicated on drawings.

N. Install unions in piping, NPS 2 and smaller, at final connections of equipment, and elsewhere as indicated.

O. Install flanges in piping, NPS 2-1/2 and larger, at connections to equipment, pumps, valves and elsewhere as indicated. Do not use flanges to join runs of piping together or at elbows, tees,

etc., in order to avoid field welding or brazing (i.e. pre-fabricated piping shall not be joined with flanges).

P. Identify piping as specified in Division 23 Section "Mechanical Identification."

Q. Dielectric Fitting: Provide dielectric fitting where copper piping is connected to steel piping.

R. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the top of the main pipe.

S. Coordinate installation of temperature and pressure sensor wells with Division 23 Section “Instrumentation and Controls for HVAC.”

T. Install escutcheons at exposed penetrations of walls, ceilings and floors.

4.3 UNDERGROUND CHILLED WATER PIPING INSTALLATIONS

A. Pre-Insulated underground chilled water piping shall be installed in strict accordance with manufacturer’s recommendations. Joints and fittings shall be butt fusion welded with equipment furnished by piping system manufacturer. Pipe excavation and bedding material shall be per manufacturer’s requirements.

4.4 SLEEVES

A. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs. Sleeves are not required for core drilled holes.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
      b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
      c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 for sheet metal flashing and trim.
         1) Seal space outside of sleeve fittings with grout.
   4. Except for exterior wall and slab-on-grade penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 for joint sealant materials and installation requirements..

B. Exterior Wall and Slab-On-Grade Pipe Penetrations:
   1. Seal penetrations using sleeves and mechanical sleeve seals.
   2. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   3. Install steel pipe for sleeves smaller than 6 inches in diameter.
   4. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   5. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

4.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports."

B. Seismic restraints when required are specified in Division 23 Section "Mechanical Seismic Controls."

4.6 FIRE BARRIER PENETRATIONS

A. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 for penetration firestopping for materials.

4.7 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook".
   1. Threaded female adapter fitting shall not be used due to their tendency to leak. Instead utilize a threaded male adapter with threaded brass coupling (FxF).
D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
E. Threaded Joints: Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
F. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
G. Flanged Joints: Utilize flat-face or raised-face flanges as appropriate for service pressure and temperature. Do not mix face types. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
H. Mechanical Joints: Pipe grooving shall be in accordance with manufacturers specifications. Lubricate gasket exterior, including lips, pipe ends and housing interiors to prevent pinching the gasket during installation. Lubricant shall be as recommended by coupling manufacturer.
I. Pressure-Seal Connections: Copper and/or steel press-seal connections shall be made in accordance with manufacturers installation instructions. Installers shall be trained and certified by the press-seal manufacturer. Tubing and/or piping shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The joints shall cleaned and prepped prior to being pressed using tools approved by manufacturer.

4.8 EQUIPMENT AND TERMINAL UNIT CONNECTIONS

A. Sizes for supply and return piping connections to equipment, coils, etc. shall equal to the full branch run-out sizes indicated on the drawings. Provide reducers at equipment connections and before and after control valves, balance valves, etc. when necessary. All near-coil/equipment piping shall be full branch line size, including bypass lines, etc. and shall only be reduced for smaller diameter control valves or coil/equipment connections.
B. Where air handling units are provided with multiple (stacked) coil banks, provide divided branch supply and return piping connections to each coil in the bank, whether or not indicated on the drawings or piping details. Branch piping to each coil in the bank may be reduced from the main indicated pipe size, but not to be smaller than the coil connection sizes.
C. Install unions, in piping 2” and smaller, at final connections to each piece of equipment, on each side of control valves and elsewhere as indicated.
D. Install Flanges, in piping 2 ½” and larger, at first connections to equipment and at all flanged valves and devices.
E. Install isolation valves, control valves, balance valves, strainers, etc. in accessible locations close to connected equipment. Do not block service access to equipment.
F. Provide flexible connectors or hoses when indicated or as specified elsewhere.
G. When indicated on the drawings, provide ¾” bypass line between supply and return feed lines, upstream of coil/equipment shut-off valves, for initial hydronic system flushing and cleaning (so that coil can be isolated from flushing process). Provide ¾” ball valves on supply and return taps, and ¾” stainless steel braided hose loop between valves.

4.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
   3. Isolate expansion tanks and determine that hydronic system is full of water.
   4. Subject piping system to hydrostatic test pressure that is equal to 1.5 times the system's working pressure or 125 psi, whichever is greater. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
   5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks. Continue test for full duration.
   6. Prepare written report of testing.

C. Flushing, Cleaning and Filling:
   1. Refer to Section “HVAC Water Treatment,” for flushing, cleaning and filling and water treatment requirements for the Hydronic System.

END OF SECTION 23 21 13

SECTION 23 21 15 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following air control devices, special duty valves and specialties for hydronic piping systems (hot-water heating, chilled water, condenser water, make-up water, heat pump loop and drains).
   1. Air Control Devices
      a. Manual Air Vents
      b. Automatic Air Vents
      c. Expansion Tanks
      d. Air Separators
   2. Special Duty Valves
      a. Flow Balancing Valves - Automatic and Manual
      b. Water Pressure Relief Valves
      c. Make-up Water Pressure Regulating/Reducing Valve
   3. Hydronic Specialties
      a. Venturi Flow Meters
      b. Strainers
      c. Flexible coil connections

B. Related Section include the following:
   1. Division 23 Section "Hydronic Piping" for piping systems.
   2. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic systems.
   3. Division 23 Section “General Duty Valves for HVAC” for general duty valves not listed in this section.
   4. Division 23 Section “Pipe Expansion Fittings and Loops” for expansion fittings.
   5. Division 23 Section “HVAC Water Treatment” for accessories related to chemical water treatment and controls.

1.2 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the maximum working pressure and temperature of the associated system to which it is attached as specified in the Hydronic Piping specification but not less than 125-psig and 200 deg F.

1.3 SUBMITTALS

A. Product Data: For each type of the following:
   1. Air Control Devices: Include flow and pressure drop data
   2. Special Duty Valves: Include flow and pressure drop data.
   3. Flow Balance Valves: Provide valve schedule for each coil, terminal unit or pump served, with valve type, flow rate and valve sizing data.
   4. Hydronic Specialties, flexible connectors.

B. Operation and maintenance data: For air control devices, special duty valves and specialties.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, unless noted otherwise:
   1. Amtrol
   2. Caleffi
   3. Armstrong Pumps
   4. Spirotherm
   5. Taco
   6. Bell & Gossett

B. Manual Air Vents:
   1. Body: Bronze.
   2. Internal Parts: Nonferrous.
   3. Operator: Screwdriver or thumbscrew.
   4. Inlet Connection: NPS 1/2.
   5. Discharge Connection: NPS 1/8.
   6. CWP Rating: 150 psig.
   7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:
   1. Body: Bronze.
   2. Internal Parts: Nonferrous.
   3. Operator: Noncorrosive metal float.
   4. Inlet Connection: NPS 1/2.
   5. Discharge Connection: NPS 1/4.
   6. CWP Rating: 150 psig.
   7. Maximum Operating Temperature: 240 deg F.

D. Diaphragm/Bladder-Type Expansion Tanks
   1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   2. Diaphragm: Flexible EPDM, securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
   3. Bladder: Heavy duty butyl bladder, replaceable, full acceptance design.
   4. Air Charge Fitting: Schrader valve, stainless steel with EPDM seats.
   5. Accessories: Pressure gauge, tank drain valve.
   6. See Drawing schedule for size, type and orientation (horizontal or vertical).

E. In-Line Air Separators:
   1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
   2. Coalescing Medium: Internal, copper coalescing medium (or equivalent) to facilitate 99.6% elimination of system air and dirt (including entrained air and microbubbles) and suppress turbulence.
   3. Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
   4. Performance:
   5. Air Vent: Integral high capacity float actuated air vent at top fitting of tank.
   6. Blowdown Connection: Threaded fitting at bottom of tank.
   7. Size:
      a. Standard velocity units: Less than 1 foot of water pressure drop, entering velocity up to 4 feet per second at specified flow.
      b. High velocity units: Less than 10 foot of water pressure drop, entering velocity up to 10 feet per second at specified flow.
   8. See Drawing schedule for size and type.

2.2 SPECIAL DUTY VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "Valves."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Controls and Instrumentation."

C. Manual, Pressure-Dependent, Flow Balancing Valves, ½" to 2" size:
   1. Manufacturers:
      a. Armstrong Pumps - CBV
      b. Nexus - Ultra MB (multi-turn plug) or Ultra XB (ball)
      c. Flow Design - UA-SBS
      d. Griswold Controls - Quick-Set
      e. Red-White
   2. Body: Brass body, ball or plug type with calibrated orifice or venturi.
   3. Ball: Stainless steel.
   4. Plug: Brass or Resin.
   5. Ball Seal: Teflon, PTFE.
   6. End Connections: Threaded or socket (sweat).
   7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
   8. Handle Style: Lever or multi-turn, with memory stop to retain set position.
   9. CWP Rating: Minimum 125 psig.
   10. Maximum Operating Temperature: 250 deg F.
   11. Sizing: Select valve size at mid-range of coil/pump design flow.

D. Manual, Pressure-Dependent, Flow Balancing Valves, 2-1/2" and larger.
   1. Manufacturers:
      a. Nexus - NVFB
      b. Flow Design - AF/AG/AW
      c. Griswold Controls – QuickSet
      d. Red-White
   2. Body: Steel body, cast-iron butterfly valve with flow venturi.
   3. Stem: Stainless steel.
   4. Disc: Bronze.
   5. Seat: EPDM.
   6. End Connections: Flanged, welded or grooved.
   7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
   8. Handle Style: Worm gear hand wheel, with memory stop to retain set position.
   9. CWP Rating: Minimum 125 psig.
   10. Maximum Operating Temperature: 250 deg F.
   11. Sizing: Select valve size at mid-range of coil/pump design flow.

E. Automatic, Pressure Independent, Flow Balancing Valves, ½" to 2":
   1. Manufacturers:
      a. Griswold Controls - K Valve
      b. Flowcon - K Valve
      c. Flow Design - AC-SBS
      d. Nexus – UM
      e. Red-White
   2. Body: Brass with replaceable flow cartridge.
   3. Flow Cartridge Assembly: Stainless steel cartridge & spring, tamper proof, self cleaning, and removable.
   4. Combination Assemblies: Include stainless steel ball valve.
   5. End Connections: Threaded or socket (sweat).
   6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
   7. Identification Tag: Marked with zone identification, valve number, and flow rate.
   8. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
   9. Minimum CWP Rating: 175 psig.
   10. Maximum Operating Temperature: 200 deg F.
   11. Sizing: Select valve size at mid-range of coil/pump design flow.

F. Automatic, Pressure Independent, Flow Balancing Valves, 2-1/2" and larger:
   1. Manufacturers:

a. Griswold Controls - Wafer
b. Flowcon - Wafer
c. Flow Design - WS
d. Nexus – UMW
e. Red-White

2. Body: Ductile iron with multiple replaceable flow cartridge.
3. Flow Cartridge Assembly: Stainless steel cartridge & spring, tamper proof, self cleaning, and replaceable.
4. End Connections: Wafer style for mounting between flanges or butterfly valves. Contractor's option to use grooved or flange style bodies.
5. Pressure Gage Connections: Integral seals for portable differential pressure meter.
6. Identification Tag: Marked with zone identification, valve number, and flow rate.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 200 deg F.
10. Sizing: Select valve size at mid-range of coil/pump design flow.

G. Water Pressure Relief Valve

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol
   b. Armstrong Pumps
   c. Bell & Gossett
   d. Conbraco
   e. Spence Engineering Co.
   f. Watts Regulator Co.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: brass, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

H. Make-Up Water Pressure Regulating/Reducing Valve:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol
   b. Armstrong Pumps
   c. Bell & Gossett
   d. Conbraco Industries
   e. Spence Engineering Co.
   f. Watts Regulator Co.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: brass, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.3 HYDRONIC SPECIALTIES

A. Venturis:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the following product or equal product upon prior approval.
      a. Hyspan Series V1 for ½" through 2" size
      b. Hyspan Series V5 for 2 ½" through 10" size..
   2. Body: One-piece brass or bronze threaded ½" through 2" size. Sizes 2½" to 10" shall consist of one-piece steel, with weld or flanged ends.
   3. Taps: Two built-in sensing taps, nipples, shut-off valves and quick connect couplings.
   4. Identification: Identification tag on chain giving pipe size, venturi series, system, meter reading at minimum and maximum flow rates.
   5. Size: Diameter and rating shall be selected by manufacturer for maximum accuracy and minimal pressure drop at full range of flows expected and to read between 20% and full scale range on a linear meter (i.e. between 10" and 50" on a 0-50" meter).
   6. Flow Meter: Provide compatible, portable flow meter for use by test and balance agency for proper testing and reading of venturi flow rates.

B. Y-Pattern Strainers:
   1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Nibco
      b. Hammond
      c. Mueller
      d. FNW
   2. Body: ASTM A 126, 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: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
   5. CWP Rating: 125 psig.

C. Flexible Pipe and Equipment Connectors:
   1. Refer to Division 23 Section "Pipe Expansion Fittings and Loops", for pipeline and other main system expansion devices.
   2. Fan coil unit, heat pumps and other terminal units: Unless noted or specified otherwise, provide 12" flexible braided stainless steel hose connector (Flow Design Inc Model S2 or approved equivalent) at each pipe connection to the terminal unit. Install connector in a straight line without offset. Piping to be supported so that connector does not carry load.

D. Rubber Flexible Connector: ASTM F1123, fabric-reinforced rubber with external control rods and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
   1. When indicated on the drawings for hydronic pumps, chillers and other major pieces of equipment, provide twin-sphere type flexible connectors:
   2. Manufacturers:
      a. Mason Industries.
      b. Metraflex, Inc.
      c. MG Piping Products Co.
      d. Vibration Mountings & Controls, Inc.
   3. Arch Type: Multiple arches.
   4. Spherical Type: Multiple spheres.
   5. Material: EPDM.
   6. End Connections: Full-faced, integral, steel flanges with steel retaining rings.

PART 3 - EXECUTION

3.1 AIR CONTROL DEVICE INSTALLATION

A. Install manual air vents at heat-transfer coils and other high points in piping as required for system air venting. This includes high points for all branch piping to mechanical units. Install 'cane' shaped discharge tube positioned to permit draining to a portable receptacle or pipe to nearest floor drain.
B. Install automatic air vents in high points of the piping system and at the downstream ends of horizontal runs over 50' long.
C. Install in-line air separators in pump suction piping. Install drain valve on air separators NPS 2 and larger and route to nearest floor drain.
D. Support expansion tanks and air separators from building structure in accordance with manufacturer's instructions. Do not support from connected piping.

3.2 VALVE APPLICATIONS

A. Install special duty valves in accessible locations close to connected equipment.
B. Provide a minimum of 5 pipe diameters of straight unobstructed pipe upstream of any electronic flow measurement device including electronic pressure independent control valves.
C. Install flow balancing valves in the return pipe of each heating or cooling terminal, at pump assemblies and elsewhere as indicated on drawings. Valve sizes shall be selected at mid-range of flow capacity, based on design flow of coil or pump being served.
    1. A manual pressure-dependent balancing valve (or venturi) shall be used downstream of any two-way pressure independent control valve for verification of flow rate only. Valve shall not be used for balancing.
        a. Exception: Omit Balancing valve (or venturi) where the temperature control valve includes integral flow measurement capability (Belimo PIQCV) or flow can be electronically verified (Belimo ePIV).
    2. An automatic pressure-independent balancing valve shall be used downstream of any 3-way temperature control valve.
D. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.
E. Provide relief valves low-pressure side of reducing valve. Select system relief valve capacity so that capacity is greater than make up pressure reducing valve capacity.
F. Provide relief valves on pressure tanks, heat exchangers, and expansion tanks. Select equipment relief valve capacity to exceed rating of connected equipment.
G. Pipe relief valve outlets to nearest floor drain, or, on glycol systems, to the glycol recovery tank or feeder. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

3.3 HYDRONIC SPECIALTIES INSTALLATION

A. Install hydronic specialties in accessible locations.
B. Install venturis where indicated on the drawings. Provide the upstream and downstream straight piping dimensions recommended by manufacturer for proper flow reading.
C. Install strainers on inlets to control valves, pressure reducing valves, solenoid valves, in-line pumps, and elsewhere as indicated on the drawings.
D. Install NPS 3/4 nipple, ball valve and hose connection in blowdown connection of strainers NPS 2 and larger. Match size of blowdown connection for strainers smaller than NPS 2.
E. Install flexible pipe connectors on fan coil units, heat pumps and other devices where indicated.

3.4 FIELD QUALITY CONTROL

A. Prepare and perform hydronic piping tests according to Division 23 Section "Hydronic Piping".

END OF SECTION 23 21 15

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY
- A. This Section includes the following:
  1. Horizontal In-Line Pumps.
  2. Split-coupled, vertical in-line centrifugal pumps.

1.2 SUBMITTALS
- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
- C. Operation and maintenance data.

1.3 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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.1 HORIZONTAL IN-LINE PUMPS
- A. Manufacturers
  1. Armstrong Pumps Inc.
  2. Bell & Gossett; Div. of ITT Industries.
  3. Taco Pumps.
- B. Description: Factory-assembled and tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
  1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
  2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
  3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
  4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N or EPT bellows and gasket. Include water slinger on shaft between motor and seal.
  5. Packing Seal: Stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
  6. Pump Bearings: Oil lubricated; bronze-journal or thrust type.
- D. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section “Motors.”
- E. Capacities and Characteristics:
  1. See drawings for schedule.

2.2 SPLIT-COUPLED, VERTICAL IN-LINE CENTRIFUGAL PUMPS
- A. Manufacturers

1. Armstrong Pumps Inc.
2. Bell & Gossett Pumps.
3. Taco

B. Description: Factory-assembled and tested, centrifugal, split-coupled, vertical in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for vertical installation with pump and motor shafts mounted vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:
1. Casing: Cast iron, with equal suction and discharge ports, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom of volute and companion-flange connections. Provide integral mount on volute to support casing, motor and attached piping to allow removal and replacement of impeller or seals without disconnecting piping or requiring realignment of pump and motor shaft.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Stainless Steel.
4. Mechanical Seal: Seal shall be stainless steel multi-spring balanced type with Viton secondary seal, carbon rotating face and silicon carbide stationary seat. Provide 316 stainless steel gland plate. Provided factory installed flush line with manual vent.
5. All split coupled pumps shall be provided with a lower seal chamber throttling bushing to ensure seals maintain positive cooling and lubrication.
6. Provide seal flush line filter.

D. Shaft Coupling: High tensile aluminum split style coupling. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Motor: Single speed or variable speed, designed for vertical pump mounting applications, with appropriate type ball bearings, rigidly mounted to pump casing. Comply with requirements in Division 23 Section “Motors.”

G. Capacities and Characteristics:
3. See drawings for schedule.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Install pumps with seal-tite electrical cord with 24” service loop to facilitate maintenance.

D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

E. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Mechanical Vibration and Seismic Controls." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers and Supports."

F. Horizontal In-Line: Suspend in-line centrifugal pumps independent of piping. Install pumps in accessible location and a maximum 48” AFF. Use continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section “Mechanical Vibration and Seismic Controls.” Hanger and support materials are specified in Division 23 Section “Hangers and Supports.”

G. Split Coupled, Vertical In-Line: Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Mechanical Vibration and Seismic

Controls." Hanger and support materials are specified in Division 23 Section "Hangers and Supports."

H. Set vertical in-line and base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
   1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of ¾ to 1-1/2 inches between pump base and foundation for grouting.
   2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.2 ALIGNMENT

A. Vertical In-line Pumps: Alignment not required on factory aligned vertical in-line pumps.
B. Laser Align pump and motor shafts after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
C. Comply with pump and coupling manufacturers' written instructions.
D. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."
E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to machine to allow service and maintenance.
C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
E. Install check valve on discharge side of inline pumps.
F. Install flow balance valve or venturi on discharge side of suction pumps where indicated on plans.
G. Install Y-type strainer and shutoff valve on suction side of inline pumps.
H. Install suction diffuser and shutoff valve on suction side of vertical in-line style pumps.
I. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.
J. Ground equipment according to Division 26 Section "Grounding and Bonding."
K. Connect wiring according to Division 26 Section "Equipment Wiring Systems."
L. 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. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.

3.4 ADJUSTMENTS

3.5 AFTER THE PUMPS ARE INSTALLED, CHECKED OUT, STARTED AND MADE OPERATIONAL, THE TEST AND BALANCE AGENCY SHALL VERIFY ACTUAL PERFORMANCE MATCHES THE PUMP CURVES AND THAT THE SYSTEM OPERATIONAL HEAD PRESSURES ARE BEING ACHIEVED. IF BALANCE DATA INDICATES THAT THE PUMP IMPELLERS ARE OVERSIZED FOR THE ACTUAL REALIZED SYSTEM HEAD, THE IMPELLERS SHALL BE REMOVED AND TRIMMED TO SMALLER DIAMETERS, IN A FACILITY APPROVED BY THE PUMP MANUFACTURER. THE FINAL TRIMMED IMPELLERS SHALL BE REINSTALLED AND THE PUMPS RETESTED TO VERIFY PERFORMANCE. ALLOW FOR TRIMMING ALL PUMP IMPELLERS IN THE PROJECT WORK SCOPE AT NO ADDITIONAL COST TO THE OWNER.

3.6 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 21 23

SECTION 23 23 15 - REFRIGERANT PIPING AND SPECIALTIES – SPLIT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes refrigerant and condensate drain piping used for ductless split systems, air source heat pumps, furnaces with air-conditioning and Variable Refrigerant Volume (VRV) systems.

1.2 RELATED WORK

A. Section 23 05 29 – Hangers & Supports for HVAC Piping and Equipment
B. Section 23 07 00 – Mechanical Insulation
C. Section 23 54 00 – Furnaces and Condensing Units
D. Section 23 81 26 – Split-System Air-Conditioners
E. Section 23 81 30 – Air-Source Heat Pumps
F. Section 23 81 50 – Variable Refrigerant Volume (VRV) Systems

1.3 REFERENCES

A. Materials and products shall comply with the following standards:
   1. ANSI B16.22 – Wrought Copper and Wrough Copper Alloy Solder Joint Pressure Fittings
   2. ASTM B88 – Seamless Copper Water Tube
   3. ASTM B280 – Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
   4. ASHRAE 15 – Safety Code for Mechanical Refrigeration
   5. ASME B31.5 – Refrigeration Piping and Heat Transfer Components
   6. UL 207 – Refrigerant – Containing Components and Accessories, Nonelectrical

1.4 SUBMITTALS

A. Product Data: For pipe material, fittings, joining methods, materials and tools. For valves and other piping specialties.
B. Shop Drawings:
   1. For small single-zone type systems (split systems, furnaces, and heat pumps) provide manufacturer's line sizing recommendations for refrigerant piping between indoor units and outdoor units. Indicate specialty items, valves, sight glasses, filter/dryers, solenoid vlaves, expansion vlaves, etc.
   2. For multi zone VRV systems, submit complete layout of entire refrigerant piping system, showing indoor units, branch controller boxes, outdoor units, pipe routing, pipe sizes, valves and other specialty items.
C. Installer Qualifications
   1. Brazed Copper Piping: Submit installer names and certifications for fitters that are qualified to install "ACR" and medical gas grade brazed piping.
D. Field Piping Leak Test Report: Witnessed and signed by an Owner's Representative.

1.5 QUALITY ASSURANCE

A. Comply with ASHRAE 15, "Safety Code for Refrigerant Systems."
B. Order all copper refrigeration tube with each shipping unit marked with the metal or alloy designation, temper, size, and name of supplier; with soft straight lengths or coils identified with a tag indicating that the product was manufactured in accordance with ASTM B280; and with each hard temper straight length identified throughout its length by a blue colored marking not less than 3/16 inch in height and a legend at intervals of not greater than three feet that includes the designation "ACR" and pipe outside diameter.
C. Any installed material not meeting the specification requriements must be replaced with material that meets these specifications without additional cost to the Owner.

1.6 DELIVERY, STORAGE AND HANDLING

A. Promptly inspect shipments to insure that the material is undamaged and complies with specifications.
B. Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. If end caps arenot present on tube bearing the “ACR” designation, clean and re-cap in accordance with ASTM B280. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
C. Offsite storage agreements will not relieve the contractor from using proper storage techniques.
D. Storage and protection methods must allow inspection to verify products.

1.7 DESIGN CRITERIA

A. Use only new material, free of defects and scale, and meeting the lates revision of ASTM specifications as listed in this specification.
B. Where ASTM B88, type L hard temper copper tubing is specified, ASTM B88, type K hard temper copper tubing may be substituted at Contractor’s option.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING

A. ASTM B88 type L hard drawn copper tube, cleaned and capped in accordance with ASTM B280, and marked “ACR,” with ANSI B16.22 wrought copper or forged brass solder-type fittings.
B. Pre-insulated copper line-sets as approved by the AC unit manufacturer. Fittings and joints shall be brazed.

2.2 REFRIGERANT PIPING ACCESSORIES

A. Provide all refrigerant piping specialties with a maximum working pressure of full vacuum to 450 psig and a maximum working temperature of 225 F. For systems using R-410A, provide all refrigerant piping specialties with a maximum working pressure of full vacuum to 700 psig and a maximum working temperature of 225 F.
B. Manufacturers:
   1. Meuller Streamline
   2. Parker Sporlan
   3. Superior HVACR
   4. Prior approved equal.
C. Service Valves: Forged brass body with rupture proof stem, brass cap and auxiliary port. Full port chromium plated ball valve. Copper sweat connections.
D. Flexible pipe connectors: Double braided bronze hose flexible pipe connectors with brazed end connections.
E. Filter Dryers: For circuits 10 tons and over provide angle pattern filter dryers with replaceable core. For circuits below 10 tons provide straight pattern filter dryers without replaceable core.
F. Sight Glasses: Two piece brass construction with brazed end connections. Include color indicator for sensing moisture.
G. Solenoid Valves: Two way normally closed with two piece brass body, full port, stainless steel plug, stainless steel spring, Teflon diaphragm and solder end connections. Provide replaceable coil assembly.
H. Hot Gas Bypass Valves: Provide with integral solenoid valve, external equalizer connection and adjustable pilot assembly.
I. Thermostatic Expansion Valves: Brass body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections.
J. Charging Valves: Provide ¼” SAE brass male flare access ports with finger tight, quick seal caps. Provide 2-inch long copper extension sections.
K. Check Valves: Spring loaded type with bronze body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections.

2.3 REFRIGERANT PIPING SUPPORT

A. Metal pipe hangers must not come in direct contact with the refrigerant piping. Utilize hangers that support the piping on the outside of the insulation, or hangers that incorporate a non-metallic inserts or non-metallic pipe hangers. Do not allow copper refrigeration piping to come in direct contract with dis-similar metals.

2.4 REFRIGERANTS

A. Manufacturers:
   1. DuPont Company
   2. Honeywell, Inc.
   3. INEOS Flour America LLC
   4. As recommended by AC Equipment manufacturer.

B. Refrigerant type, R-134a, R-410c, etc. as required by system.

2.5 REFRIGERANT PIPING COVERS

A. Manufacturers:
   1. Slimduct
   2. Diversitech
   3. Prior Approved Equal

2.6 CONDENSATE DRAIN PIPING

A. Cold Condensate-Drain Piping (indoor fan coils, air handlers, etc.)
   1. Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Liquid & Gas Lines between indoor and outdoor units, or, on VRV systems, between indoor units and Branch Selector (Controller) boxes.
   1. Type L copper ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
   2. Pre-insulated Type L copper ACR tubing line-sets when specifically allowed by AC unit manufacturer, with wrought-copper fittings with brazed joints.
      a. Flared connections may be used at equipment connections when specifically allowed by AC unit manufacturer.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install all piping parallel to building walls and ceilings and at heights that do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

B. Do not route piping through transformer vaults or above transformers, panel boards, or swtichboards, including the required service space for this equipment, unless the piping is serving this equipment.

C. Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

D. Arrange piping to allow service and access to equipment.

3.3 REFRIGERANT PIPING

A. Firms and individuals who are experienced in the installation of refrigeration piping must install such piping.
   1. Brazing must be done by qualified technicians.

B. Pipe Joint Construction:

1. All copper joints must be brazed an have a melting point greater than 1,125 degrees F. Filler impurities shall not exceed 0.15%. Tubing to be new and delivered to the job site with the original mill end caps in place. Purge all lines with nitrogen during brazing.
2. Flared fittings may only be used at equipment connections when specifically allowed by the AC unit manufacturer.

C. Hangers and Supports:
1. Support piping and equipment as specified in Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”
2. Install hangers in accordance with manufacturers recommendations, with spacing in accordance with 2012 ASHRAE Handbook “HVAC Systems & Equipment.”
3. Utilize “cushion clamps” and other non-metallic type hangers to isolate metallic piping from hanger.

D. Pipe Covers and Enclosures:
1. Where refrigerant piping and line-sets are exposed to view within the building, or on the exterior of the building, the piping shall be enclosed in pre-manufactured, decorative type piping covers.
   a. Provide straight sections, elbow, boots, wall penetrations, etc. for a full and clean assembly.
   b. Color: white, unless indicated otherwise.

E. Refrigerant Piping Valves and Accessories:
1. Install piping valves and specialties in accordance with the manufacturer’s instructions and recommendations.

3.4 FIELD QUALITY CONTROL

A. Perform test and inspections and prepare test reports.

B. No refrigerant is to be vented directly to the atmosphere except that which may escape through leaks in the system during leak testing. During evacuation procedures, use equipment designed to recover and allow recycling of the refrigerant.

C. Leak test the system by charging the system to a pressure of 10 psig with an HFC refrigerant, with the compressor suction and discharge valves closed and with all other system valves open. Increase pressure to 550 psig with dry nitrogen. Seal any leaks that may be found and retest. Replace any mechanically attached fittings that leak with new fittings and retest.
1. Test shall be witnessed by an Owner’s Representative. Submit a signed and dated test report for each system tested.

D. After completion of the leak test, evacuate the system with a vacuum pump to an absolute pressure not exceeding 1500 microns while the system ambient temperature is above 60°F. Break the vacuum to 2 psig with the refrigerant to be used in the system. Repeat the evacuation process, again breaking the vacuum with refrigerant. Install a drier of the required size in the liquid line, open the compressor suction and discharge valves, and evacuate to an absolute pressure not exceeding 500 microns. Leave the vacuum pump running for not less than two h ours without interruption. Raise the system pressure to 2 psig with refrigerant and remove the vacuum pump.

3.5 SYSTEM CHARGING

A. Charge refrigerant directly from original drums through a combination filter-drier. Each drier may be used for a maximum of three cylinders of refrigerant and then must be replaced with a fresh drier. Charge the system by means of a charging fitting in the liquid line. Weigh the refrigerant drum before charging so that an accurate record can be kept of the weight of refrigerant put in the system. If refrigerant is added to the system through the suction sie of the compressor, charge in vapor form only.

END OF SECTION 23 23 15

SECTION 23 25 00 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following HVAC water-treatment systems:
   1. Bypass chemical-feed equipment and controls.
   2. Chemical treatment test equipment.
   3. Glycol Feeders.
   4. Flushing, cleaning and filling.
   5. HVAC water-treatment chemicals.
   6. Glycol mixture for freeze protection.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME).
B. ASTM International:
C. ASTM D859 – Standard Test Method for Silica in Water.
D. ASTM D1067 – Standard Test Methods for Acidity or Alkalinity of Water.
E. ASTM D1068 – Standard Test Methods for Iron in Water.
F. ASTM D1126 – Standard Test Method for Hardness in Water.
G. ASTM D3370 – Standard Practices for Sampling Water from Closed Conduits.
H. American Water Works Association (AWWA):
   1. AWWA C700 – Cold Water Meters-Displacement Type Bronze Main Case.
   2. National Electrical Manufacturers Association (NEMA):
   3. NEMA 250 – Enclosures for Electrical Equipment.
I. National Fire Protection Association (NFPA):
   1. NFPA 70 – National Electrical Code (NEC).

1.3 SUBMITTALS

A. Product Data: For each type of equipment, device or product indicated.
B. Glycol Anti-freeze characteristics.
C. Glycol Feeders, pot feeders, side stream filters, coupon racks, glycol recovery tanks.
D. Water treatment equipment and devices.
E. Chemicals and MSDS sheets.
F. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems.
G. Retain subparagraph below if equipment includes wiring.
H. Wiring Diagrams: Power and control wiring.
I. Piping Diagrams.
J. Field quality-control test reports.
K. Water Analysis: Test and report water quality available at Project site.
L. Glycol mixture freeze protection temperature rating (test) for each system.
M. Final system water quality test reports for each system.
N. Other Informational Submittals:
   1. Flushing and Cleaning Plan.
   2. Flushing and Cleaning Witness Forms.
   3. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article.
   4. Water sample containers.

1.4 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.

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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including condenser water and chilled water, shall have the following water qualities:
   1. pH: Maintain a value within 9.0 to 10.5.
   2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
   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.

D. Microbiological Limits:
   1. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
   2. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
   3. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
   4. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
   5. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

2.2 WATER TREATMENT COMPANIES

A. Approved Water Treatment Companies:
   1. Flint Services, Incorporated.
   2. King Total Water Systems.
   3. Prior approved equal.

2.3 CHEMICAL WATER TREATMENT:

A. Chemical Properties:
   1. Ferrous metal corrosion inhibitor shall provide corrosion protection by the use of sodium nitrite, sodium nitrate, and sodium hydroxide technique.
   2. Nonferrous metal corrosion inhibitor product shall provide corrosion protection by the use of tolytriazole.
   3. System shall be treated with biocides to prohibit biological growth within the closed system.
   4. Furnish one year's supply of formula for control of biological growth, scale, sludge, and corrosion in the hydronic systems. Formulation shall not contain any ingredients which are harmful to system materials and construction.
   5. The water treatment chemical and service supplier shall furnish basic water test equipment, including carrying case and reagents for use with the supplier's products and test equipment for determination of treatment residual. Where specialized or supplementary equipment is required, it shall be furnished as a part of the offering.

B. Glycol Anti-freeze Solutions:
   1. System subject to potential freezing (hot water heating, chilled water, eat pump loops, closed circuit cooling towers, snow-melt) shall be filled with propylene glycol anti-freeze solutions.

2. Propylene glycol shall be DOWFROST HD inhibited propylene glycol.
3. Systems shall be filled with 30% glycol & 70% deionized water, pre-mixed solutions, unless noted otherwise (10°F freeze protection, – 20°F burst protection).
4. Test equipment for Dowfrost glycol or Tech. grade glycol shall be furnished and shall be approved by glycol manufacturer for testing their product.

2.4 GLYCOL FEEDER

A. Provide complete free standing system to maintain pressure and glycol level in closed loop system. The closed loop system pressure shall be maintained by monitoring the pressure and adding a premixed glycol solution when the pressure drops below a preset value. When the system pressure increases above the pressure switch set point, the control unit will shut the glycol feed off.
B. Single or Dual system feeder as required for each closed loop glycol treated system.
C. 50 gallon polyethylene tank in a steel frame.
D. Bronze rotary gear pump (1.5 gpm @ 100 psi).
E. Adjustable pressure switch.
F. Provide a back flow prevention valve in the discharge of the pump to prevent system solution from backing up in to the feed tank when the glycol pump is off. A low level cutoff switch shall be provided to prevent the pump from running when the supply tank is empty. The cutoff switch also activates an alarm buzzer and closes the alarm dry contacts. An adjustable pressure relief valve to be installed in the discharge lines. If system pressure increases beyond the limit set on the pressure relief valve, the valve opens, and the glycol solution is bypassed back into the solution tank.
G. The control panel shall be housed in a NEMA type enclosure and is prewired to include all electrical connections to the pump, pressure switch and level switch. An 18 gauge, 3 wire, 7’6”, 115VAC power cord is prewired and supplied with the system.
H. Warranty: Glycol Feed Systems shall have a one year warranty, from the date of installation, against manufacturing defects in material and workmanship which develop in the service for which they are designed.
I. Manufacturers:
    1. IAT Construction Services.
    2. Neptune.
    3. JL Wingert & Co.
    4. John Wood Co.
    5. Flint Services, Incorporated.
    6. Or approved equal.

2.5 GLYCOL RECOVERY TANKS

A. Glycol recovery tanks shall be 35 gallon high density polyethylene tanks (180° F. rating), similar to GTP, Inc. Model P-35-H poly tank, with removable cover and hinged inspection lid. Provide with tank drain fitting and drain valve.

2.6 BYPASS CHEMICAL FEEDER

A. Description:
    1. Chemical Bypass Feeder: Shall consist of continuous electric welded tube body, code semi-elliptical heads inlet/outlet/drain and fill port and mounting legs. Bypass feeder will be installed as per manufacturer’s recommended installations and be supplied with noted accessories. Feeder is rated for 200 PSI @ 200ºF.
    2. Dome Bottom: Feeder shall have side inlet and outlet ¾” fittings, 3½” ¼ turn heavy duty cast closure with Buna-N O-ring, bottom drain ¾”.
    3. Feeder Size: Shall be of proportionate size as to not create strain to fill/recharge.
        a. 5 gallon vessel, 10” diameter, height not to exceed 32 inches, unless indicated otherwise on the drawings.
    4. Accessories: Feeder shall be supplied with the following accessory items to complete installation:

a. Filter Feeder: When indicated on the drawings, provide feeder unit with internal stainless steel basket and 25 micron high temperature rated (175°F) bag filter. Provide two (2) sets of filter bags.

B. Manufacturer:
1. JL Wingert & Co.
2. Neptune
3. John Wood
4. Approved equal.

2.7 SIDESTREAM FILTER

A. Provide 304L stainless steel body cartridge type sidestream filter housing and replaceable high temperature (to 175 deg. F) poly cartridges, suitable for glycol duty. Band clamp and swith-bolt lid closures. Knife edge seals at both ends of cartridge. Nominal size shall be 4(10") cartridges, rated to 25 gpm, unless otherwise indicated on the plans. Provide two (2) spare sets of cartridges.

B. Shelco Filters Model 4FQS1, or equal.

2.8 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

C. Two-station rack for open and/or closed-loop systems.

2.9 CHEMICALS

A. Chemicals shall be 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.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site. Provide copies of water chemistry analysis to A/E along with recommendations for chemical treatment program to meet specified system water quality levels.

3.2 INSTALLATION

A. Install chemical application equipment on stands or brackets as recommended by manufacturer. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible.

B. Install glycol feeder unit where indicated. Connect outlet from pressure pump to system connection point. Fill tank with premixed glycol-water solution as specified, after system is filled and charged. Adjust pressure switch setpoint to match system fill pressure (expansion tank fill pressure). Test alarms and low-level pump lock-out safety.

C. Bypass Chemical Feeders, Corrosion Rack and Side-Stream Filters: Coordinate installation with Section 23 21 13 contractor.

D. Install glycol recovery tank adjacent to boilers or as indicated.

E. Install automatic chemical-feed equipment for closed-circuit cooling tower cooler spray water, or open type cooling tower and include the following:
1. Install water meter in makeup water supply.
2. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

3. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into cooling tower make-up water supply line.

F. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.

G. Install TDS controller with sensor and bleed valves.
   1. Bleed valves shall cycle to maintain maximum TDS concentration.

H. Install pH sensor and controller with injection pumps and solution tanks.
   1. Injector pumps shall operate to maintain required pH.

I. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.

J. Injection pumps shall operate to feed biocide on an alternating basis.

K. Install interconnecting control wiring for chemical treatment controls and sensors under this Section.

L. Mount sensors and injectors in piping circuits.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Coordinate location of required drain and fill valves with hydronic piping contractor so that all necessary flush and fill locations are properly located and provided.

C. Install piping adjacent to equipment to allow service and maintenance.

D. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 23 21 13 – Hydronic Piping.

E. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "Valves."

F. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.

G. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.

H. Ground equipment according to Division 26 Section "Grounding and Bonding."

I. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 SYSTEM CLEANING AND FLUSHING

A. Phased system completion: If the work involves a phased project, portions of the hydronic water system(s) will be constructed and activated at different times based on phased completions dates. The water treatment system, cleaning, flushing and filling activities shall be sequenced to accommodate all the various stages so that the system may be made operational and expanded as phases are completed.

B. All new piping systems shall be flushed, cleaned, disinfected, etc. by specified Water Treatment provider. Work shall be accomplished in accordance with the following requirements. Work shall be fully documented by means of certificates stating work accomplished, methods used and date work was done.

C. Existing piping systems: Where existing hydronic piping systems are to be temporarily maintained and used for phasing purposes, but are indicated for eventual demolition, flushing and cleaning is not required. Where existing hydronic piping systems are to be maintained and reused for the permanent system, the existing piping shall be drained, flushed, cleaned, filled and treated in the same manner as new piping. New equipment, boilers, chillers, etc., shall not be connected to old, existing hydronic piping systems until the old systems have been cleaned.

D. Flushing and Cleaning Plan: Prepare a written plan for review and approval by the A/E for the methods and procedures to be used for flushing and cleaning each hydronic piping system.

E. Address phasing requirements when systems must be built and activated in multiple phases.

F. Address tie-in and drain points for each section of piping. Address location of temporary bypass lines, drains, etc.

G. Address plans for temporary isolation of factory cleaned equipment and coils, removal of control valves and auto-flow cartridges.

H. Address plans for circulating fluids with temporary pumps or the use of the system pumps (if approved by the A/E).
I. Address methods for determining when system is clean and the cleaning agents are considered rinsed out.
J. Discuss procedures for cleaning strainers.
K. Address final fill procedures, removal of bypasses, reinstallation of valves and cartridges, purging of all air, dosing of final chemical additives and system pressurization.
L. Address plans for legal disposal of fluids, glycol mixtures and/or cleaning agents.
M. Water Piping: Clean systems with chemicals as recommended by water treatment specialist.
N. Pre-Cleaning Procedures:
    1. Pressure test piping as required.
    2. Isolate any existing system piping that is already cleaned and not part of the project new work.
    3. Install temporary bypass lines at all coils valve sets and all factory cleaned equipment. In lieu of temporary bypass lines, if approved by the Owner, temporarily remove control valves (and install bypasses), auto-flow cartridges and other pipe-line devices that could be plugged by debris during flushing.
    4. At terminal device coils consider temporarily removing coil connections and looping supply and return lines together during flushing.
    5. Make sure all start-up and system strainers are installed.
O. Initial flushing: Flush system with clear water. Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 1.8 m/s (6 feet per second), if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the A/E. Have procedure witnessed and signed-off on Pipe Cleaning Record Witness Form.
P. Cleaning: Re-fill system with clear water and add cleaning products, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 1.8 m/S (6 feet per second). Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing. Have procedure witnessed and signed-off on Pipe Cleaning Record Witness Form.
Q. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour or until all cleaning chemicals are removed. Pull and clean all strainers. Remove start-up strainers on pumps and replace with final strainers. Have procedure witnessed and signed-off on Pipe Cleaning Record Witness Form.
R. Trim out system by removing temporary bypasses, drains, hoses, pumps, etc. and reinstall control valves, auto-flow cartridges, etc.
S. Fill system with approved treated fluid and chemicals treatment. Purge air from all coils, equipment, piping, etc. Pressurize system with make-up water valve or glycol feeder as applicable.
T. Hydronic Piping Systems Final Filling:

1. Provide test report confirming the parameters have been met and include a copy of the report in the O & M Manual.
    a. Provide certified water samples in sealed, clear plastic 1.0 gallon bottles at the beginning and end of each flush and fill stage, before glycol has been added. Treatment Contractor shall seal, sign, label and date each sample and turn over to A/E for proof of water quality.

U. Final Filling: After final cleaning is completed and tested, fill the systems as follows:
1. Water Only Systems: Fill with clear water from building domestic supply.
2. Glycol Anti-Freeze Systems: Fill with pre-mixed solution of propylene glycol and deionized water to the specified percentage of glycol.

V. Final Chemical Treatment: Add water treatment chemicals to achieve final water chemistry levels. Replace start-up strainers at suction diffusers and air separators with permanent strainers. Chemicals shall be non-toxic. Actuate all control valves during system cleaning and flushing.

W. Final Water Quality Report: Provide certified water quality analysis of final treated system water chemistry levels to confirm specified levels have been achieved.

X. Fluid Disposal
1. All excess fluids used in the water treatment activities shall be disposed of in a safe and legal manner. Obtain authorization from the local waste water agency before discharging chemically treated or anti-freeze glycol fluid solutions to floor drains. If local drainage to the sanitary system is not allowed, make arrangement to transport fluids off-site for disposal at an approved facility.

3.5 FIELD QUALITY CONTROL

A. Test, inspections and reports.

B. Provide water analysis test report showing final chemistry levels for each system.

C. Turn over sealed water samples for each system to A/E.

D. Test and record freeze protection temperature levels for each glycol system.

E. Test automatic chemical feed, bleed and measurement equipment for cooling tower systems and adjust dosing and feed timers to achieve required water quality.

F. Spare Chemical and Fluids:
1. Provide sufficient water treatment chemicals, for the anticipated consumption rate, for a 1-year period.

G. Glycol: During the course of the 1-year warranty period, the glycol feeder tank shall be replenished with pre-mixed glycol/water solution as necessary due to any loss in system fluid as a result of warranty work. Top off tank at the end of the 1-year warranty.

3.6 DEMONSTRATION

A. Water treatment provider to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 1 Section "Demonstration and Training."

3.7 PIPING SYSTEM CLEANING RECORD WITNESS FORM

System: _____

Pre Cleaning Check List:

	DNA	Yes	No	Initials	Date
System pressure tested					
System Temporary Bypasses & Drains Installed					
Construction screens installed in circulation pumps.					
Equipment Isolation Verified: - Control Valves removed or bypassed - Coil bypasses installed - Autoflow cartridges reomoved					
Comments: _____					

Cleaning Procedures:

Initial Flush:

Test Date: _____ Start Time: _____ Stop Time: _____

Comments: _____

Initials _____ Date _____

Addition of Cleaner :

Test Date: _____ Start Time: _____ Stop Time: _____

Chemical Used: _____ Amount: _____

Comments: _____

Initials _____ Date _____

Cleaner Flush :

Test Date: _____ Start Time: _____ Stop Time: _____

Comments: _____

Initials _____ Date _____

Final Fill & Addition of Inhibitor:

Chemical Used: _____ Amount: _____

Comments: _____

Initials _____ Date _____

END OF SECTION 23 25 00

SECTION 23 31 00 - HVAC DUCTS

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes:
   1. Metal round, oval, and rectangular ducts and fittings for supply, return, outside, and exhaust air-distribution systems for 1" to 4" W.G. pressure classes.
   2. Stainless steel duct for Kitchen Range Hood Exhaust application.
   3. Acoustic duct liner for sound control.
   4. Ductwork for sawdust collection systems
   5. Ductwork for fume exhaust systems.

B. See Division 23 Section on duct accessories for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 REFERENCES

A. ASTM International:
   1. ASTM A36 – Standard Specification for Carbon Structural Steel.
   2. ASTM A653 – Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process.
   3. ASTM C916 – Standard Specification for Adhesives for Duct Thermal Insulation.
   4. ASTM C1071 – Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
   5. ASTM D737 – Standard Test Method for Air Permeability of Textile Fabrics.
   6. ASTM D3776 – Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.

B. North American Insulation Manufacturers Association (NAIMA):
   1. NAIMA Fibrous Glass Duct Liner Standard

C. NFPA Compliance:
   1. NFPA 90A - "Installation of Air Conditioning and Ventilating Systems."
   2. NFPA 90B - "Installation of Warm Air Heating and Air Conditioning Systems."
   3. NFPA 96 - "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations"

D. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
   1. SMACNA "HVAC Duct Construction Standards – Metal and Flexible"
   2. SMACNA "Industrial Duct Construction"
   3. SMACNA "Duct Cleanliness for New Construction"

E. UL Standards:
   1. UL 181A-M – Closure Systems for Use with Rigid Air Ducts.

1.3 SUBMITTALS:

A. Product Data: Provide product data on duct materials, sealants and pre-manufactured items, such as duct liner, turning vanes, duct flanges, etc., intended to be used for duct construction.

B. Shop Drawings: Show fabrication and installation details for HVAC Ducts.
   1. Penetrations through fire-rated and other partitions.
   2. Duct accessories, including access doors and panels.
   3. Sheet Metal shop standards for duct construction, pressure classes, reinforcing, hanger sizes, flange construction, etc.
   4. Duct liner application and installation details.

1.4 DUCT PRESSURE AND SEALANT CLASS DEFINITIONS:

A. General Sealing Requirements per WA NREC and IMC:
   1. Pressure Class up to 3" w.g. – SMACNA Sealant Class B.
   2. Pressure Class greater than 3" w.g. – SMACNA Sealant Class A.

B. Supply ducts between Terminal Unit and space being served, room return air boots and transfer air ducts:
   1. Pressure Class: 1” W.G.
C. General Exhaust duct system serving Exhaust Fans:
   1. Pressure Class: 1” W.G.
D. Return Air ducts serving all AHUs:
   1. Pressure Class: 2” W.G.
E. Primary Supply Ducts between VAV AHUs and Terminal Units (VAV systems):
   1. Pressure Class: 4” W.G.
F. Primary Supply Ducts between single zone AHUs and air outlets (constant volume systems):
   1. Pressure Class: 2” W.G.
G. Special Conditions:
   1. Return air ducts open to ceiling plenums shall be constructed 2-gauges heavier than SMACNA requirements, from unit connection point to 15 feet downstream.
   2. Metal Supply air ducts exposed to line of sight upstream of duct silencers or fabric ductwork shall be constructed 2-gauges heavier than SMACNA requirements.
   3. Lab Exhaust Duct systems shall be constructed to a 2” W.G. pressure class with a Class A seal.
   4. Exhaust ducts serving canopy hoods and welding exhaust systems shall be Pressure Class -4” W.G., Sealant Class A.
   5. Exhaust ducts serving the sawdust collection system shall be Pressure Class -10” W.G., Sealant Class A.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. 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: Lock-forming quality; complying with ASTM A653 and having G60 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

2.2 SEALANT MATERIALS:

A. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 181A-M listed. Maximum Volatile Organic Content shall be 45 gpl (water excluded) or less. Product shall be equal to Hardcast Versa-Grip 181.

2.3 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
   1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
   2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
D. Trapeze and Riser Supports: Galvanized-steel shapes and plates complying with ASTM A36.

2.4 DUCT FABRICATION:

A. 1” to 2” W.G. Pressure Class:

1. Material shall be galvanized steel with the following exception:
   a. Exhaust systems serving kitchen range hood grease exhaust or dishwashers shall be as specified below.
2. Duct sizes shown on drawings are outside nominal dimensions for sheet metal ductwork. Where ductwork is indicated on the drawings to be lined, an allowance for 1” or 2” thick insulation is included and duct sizes do not need to be increased to compensate for the insulation.
3. Round ducts and fittings: All round ductwork shall be spiral lock seams with spot welded sealed manufactured fittings, galvanized steel.
   a. Manufacturers:
      1) United McGill
      2) Ventline.
      3) Accu Duct.
4. Round or oval ductwork indicated to be lined shall have a perforated liner and shall be equal to United Sheet Metal Acousti-K27. Unless noted otherwise on the drawings, insulation shall be 1" thick.
5. Rectangular to round branch duct connections shall use spin-in fittings: Spin-in fittings shall be DuroDyne or Air Control Products equal to Air Control Products Model S-SM-C with damper for unlined ductwork or Air Control Products Model S-DB-C with damper for lined ductwork.
6. Rectangular to rectangular branch duct connections shall use 45-degree entry. Straight taps are not allowed.
7. Rectangular Elbows: All 90-degree rectangular elbows shall contain turning vanes. See section 23 33 00 “Duct Accessories” for turning vane fabrication requirements.
8. Round Elbows: All round elbows shall be pleated or segmented with a centerline radius of 1.5 times the cross-section diameter.
9. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
   a. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
   b. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
10. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
    a. Manufacturers:
       1) Ductmate Industries, Inc.
11. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
    a. Manufacturers:
       1) Ductmate Industries, Inc.
       2) Lockformer.
12. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359-inch-thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

B. 4” W.G. Pressure Class:

1. Ductwork shall be galvanized steel of the US Standard gauges as specified in HVAC Duct Construction Standards, Metal and Flexible, latest Edition as published by SMACNA.
2. Duct sizes shown on drawings are outside nominal dimensions for sheet metal ductwork. Where ductwork is indicated on the drawings to be lined, an allowance for 1" thick insulation is included and duct sizes do not need to be increased to compensate for the insulation.

3. Round or oval ductwork indicated to be lined shall have a perforated liner and shall be equal to United Sheet Metal Acousti-K27. Unless noted otherwise on the drawings, insulation shall be 1" thick.
4. All fittings shall be spot welded with machine formed entrances to branch fittings. No fabricated fittings using screw fasteners will be allowed. All welded seams shall be covered with one coat of rust inhibiting paint applied to both interior and exterior of duct or fitting.
5. Elbows: centerline radius shall be 1.5 times the cross-section diameter. Sizes shall be constructed with five pieces for 60 degree through 90 degree turns and three pieces for turns less than 45 degrees, and two pieces for turns less than 30 degrees.
6. Round ducts and fittings: all round ductwork shall be spiral lock seams with spot welded sealed manufactured fittings, galvanized steel. All sealant used shall be water based with a minimum Volatile Organic Content of 45 gpl (water excluded) or less.
7. Joints in duct and fittings up to and including 36" in diameter shall be made with couplings. Larger duct and fittings shall be jointed with companion flanges of United McGill Corp. design. Flat oval ducts and fittings - flat oval ductwork shall be fabricated with spiral lock construction through 24" minor axis.
8. Reinforcing of flat oval ducts shall be in accordance with the recommendations of the United McGill Corp. and as specified in HVAC Duct Construction Standards, Metal and Flexible, latest Edition as published by SMACNA.
9. Joints in oval duct and fittings up to and including 41" wide or 26" high shall be made with coupling.
10. Manufacturers:
    a. United McGill Corp
    b. Accu Duct
    c. Metal Fab

2.5 RESIDENTIAL RANGE EXHAUST HOOD AND DRYER EXHAUST DUCT:

A. Exhaust system serving the residential range exhaust hoods or clothes dryers shall be constructed of 24 gauge fully sealed aluminum or stainless-steel ductwork. Sheet metal screws are prohibited, use lap joints or rivets.

2.6 DUCT LINER:

A. Manufacturers:
    1. JM Permacote Linacoustic Mat Faced
    2. CertainTeed
B. Products meeting ASTM C1071; K(ksi) value of 0.25 (R=4.0 per inch)at 75 degrees F, coated air side for maximum 5,000 ft/min air velocity, 1.5 psf density. Provide EPA registered, anti-microbial agent so that the liner will not support the growth of fungus or bacteria.
C. Adhesive: UL listed waterproof type.
D. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.
E. Where ductwork is indicated on the drawings to be lined, an allowance for 1” or 2” thick insulation is included and duct sizes do not need to be increased to compensate for the insulation.

2.7 KITCHEN TYPE-I HOOD GREASE EXHAUST DUCT AND TYPE-II KITCHEN HOOD AND DISHWASHER EXHAUST HOOD:

A. Range Hood Exhaust Ducts: Comply with NFPA 96.
    1. Concealed: Carbon-steel sheet, 16 gauge.
    2. Exposed: Type 304, stainless steel with finish to match kitchen equipment and range hood, 18 gauge.
    3. Joints, seams and penetration of grease ducts shall be made with continuous liquid tight weld or braze made on the external surface of the duct system.
    4. Provide flange connections when connecting to range hood and exhaust fan.
    5. Provide access doors in ductwork as required by IMC.
    6. Door Accessories:

a. Provide Automatic Shut off (Kill) switches on fan access doors.

B. Dishwasher Hood Exhaust Ducts: Comply with NFPA 96.
   1. Concealed: Type 304, stainless steel sheet, 20 gauge.
   2. Exposed: Type 304, stainless steel with No. 4 bright finish to match kitchen equipment and range hood, 18 gauge.
   3. Joints, seams and penetration of dishwasher exhaust ducts shall be made with continuous liquid tight weld or braze. Exposed joints shall be ground and polished smooth to match finish of duct.
   4. Provide flange connections when connecting to exhaust fan.
   5. Dishwasher exhaust hood shall be custom built to match dishwasher furnished on the project and as detailed on the plans.

2.8 FUME HOOD EXHAUST:

A. Exhaust ductwork serving Fume Hoods shall be 18 gauge, stainless steel, using continuous external welded joints. Slope exhaust duct back to hood for drainage. Hood stack and weather stack at exhaust fan discharge shall be 18 gauge, stainless steel.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated. Ductwork for kitchen grease exhaust duty shall be constructed and installed in accordance with the IMC and NFPA 96.

B. Install ducts with fewest possible joints.

C. Take due care to prevent piping, conduit or other building materials from touching ductwork.

D. Install fabricated fittings for changes in directions, size, and shape and for connections. Use spin-in fittings to connect rigid or flexible round ductwork to rectangular duct for pressure class construction of 2” W.G. or less.

E. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated. Ducts exposed to view in finished spaces shall be installed with special attention to workmanship and quality control. Symmetry, alignment and quality of fittings shall be judged by their final appearance and corrected if found to have poor workmanship. Sealant on exposed to view joints shall be applied internally to fittings and wiped clean on exterior of ductwork. Contractor’s option on exposed ductwork to utilized gasketed fittings equal to McGill Uni-Gasket Fitting.

I. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

J. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

K. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

L. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

M. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section “Penetration Firestopping.”

N. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

3.2 SEAM AND JOINT SEALING:

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.
B. Seal ducts before external insulation is applied.
C. Sealant on ducts exposed to view in occupied spaces shall be applied internally to fittings and wiped clean on exterior of ductwork.

3.3 RANGE HOOD EXHAUST DUCTS, SPECIAL INSTALLATION REQUIREMENTS

A. Install ducts without dips or traps that may collect residues unless traps have continuous or automatic residue removal.
B. Install access openings at each change in direction and at intervals defined by NFPA 96; locate on sides of duct a minimum of 1.5 inches from bottom; and fit with grease-tight covers of same material as duct.
C. Do not penetrate fire-rated assemblies except as permitted by applicable building codes.
D. Comply with NFPA 96 for fire-rated enclosures of grease ducts; provide fire rated duct enclosure or insulated duct with listed fire rated assembly in accordance with Section 23 07 00 – Mechanical Insulation.

3.4 DUCT LINER INSTALLATION

A. All duct liner shall be installed in accordance with the requirements of the NAIMA Fibrous Glass Duct Liner Standard, or SMACNA HVAC Duct Construction Standard and the project specifications.
B. The liner shall be cut and fitted to assure all joints are neatly and tightly butted with no interruptions or gaps. Where ductwork is indicated on the drawings to be lined, an allowance for 1” or 2” thick insulation is included, and duct sizes do not need to be increased to compensate for the insulation.
C. Where ducts are also specified to be thermally insulated, the duct liner shall be counted towards the total required insulation thickness (i.e. the internal liner thickness may be subtracted from the total duct system insulation thickness otherwise specified).
D. All duct liner products shall be adhered to the sheet metal ductwork using an adhesive meeting the requirements of ASTM C916. The adhesive film coverage shall be a minimum 90% of the metal surface.
E. Additionally, secure duct liner with mechanical fasteners at spacing in accordance with NAIMA or SMACNA standards.
F. All transverse joints shall be edge-coated. Metal nosing on leading or trailing edges is required where lined duct transitions to unlined metal duct.

3.5 DUCT SUPPORTS

A. Duct Supports shall be in accordance with SMACNA’s standards.
B. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
C. Support vertical ducts at maximum intervals of 16 feet and at each floor.
D. Install upper attachments to structural elements and joists. See structural plans and drawing details for additional limitations and criteria. Do not use eccentric beam clamps on joists. Do not attach duct hangers to bare metal decking (roof decks).
E. Install concrete inserts before placing concrete.
F. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.6 DUCTWORK PROTECTION:

A. During construction provide temporary closures of metal or taped polyethylene at all openings in ductwork to prevent construction dust from entering ductwork system.

3.7 CONNECTIONS:

A. Make connections to equipment with flexible connectors according to Section 23 33 00 - Air Duct Accessories.

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.8 DUCT LEAKAGE TESTING

A. Contractor shall test 25% of all new medium pressure ductwork (3” w.g. and above pressure class).

B. Duct sections shall be tested from the discharge of AHU to the inlet of all the downstream terminal units. Contractor shall temporarily blank-off or cap taps and branches not associated with testing.

C. The leakage amount shall not exceed the allotted amount for the pressure class or the allotted amount for that portion of the system, whichever is applicable.
   1. Rectangular Duct Construction Class 3” w.g. and greater – Leakage Class 6.
   2. Round Duct Construction Class 3” w.g and greater – Leakage Class 3.

D. Leakage test procedures shall follow the outlines and classifications in the SMACNA HVAC Duct Leakage Test Procedures. Testing shall be witnessed by a designated Owner’s representative.

E. If the duct section fails to meet allotted leakage level, the contractor shall modify to bring it into compliance and shall retest it until acceptable leakage is demonstrated.

F. Tests and repairs shall be completed prior to concealment of ducts.

END OF SECTION 23 31 00

SECTION 23 33 00 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   A. Backdraft dampers.
   B. Volume dampers.
   C. Turning vanes.
   D. Duct-mounting access doors.
   E. Pressure relief doors.
   F. Flexible connectors.
   G. Flexible ducts.
   H. Duct accessory hardware.
   I. Combination fire and smoke dampers.
   J. Outside Air Valve – Pressure Independent Air Controller (Ventilation Air Valve)
   K. Fire dampers.
   L. Duct Silencers.

B. See Division 28 Section "Fire Alarm" for duct-mounting fire and smoke detectors.

C. See Division 23 Section "Controls and Instrumentation" for electric damper actuators.

1.2 SUBMITTALS

A. Product Data: For the following:
   A. Backdraft dampers.
   B. Volume dampers.
   C. Turning vanes.
   D. Duct-mounting access doors.
   E. Pressure relief doors.
   F. Flexible connectors.
   G. Flexible ducts.
   H. Fire and Smoke Dampers
   I. Duct Silencers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   A. Special fittings.
   B. Manual-volume damper installations.
   C. Wiring Diagrams: Power, signal, and control wiring.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel: ASTM A 480/A 480M.

D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.
F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
G. 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.

2.2 NON-MOTORIZED, GRAVITY TYPE, BACKDRAFT DAMPERS

A. Approved Manufacturers:
   A. Air Balance, Inc.
   B. American Warming and Ventilating.
   C. Ruskin.
   D. Prior approved equal.
B. Application: Non-motorized gravity type backdraft dampers installed in ductwork distribution systems, may only be used for relief air on systems 5,000 cfm or less, in buildings less than three stories in height (WA NREC). Backdraft dampers provided for exhaust air outlets and larger relief air conditions shall be motorized type dampers (provided with the exhaust fans or field mounted). See Section HVAC Controls and Instrumentation for field mounted motorized control and/or shut-off dampers.
C. Performance: Leakage shall not exceed 20 cfm/sq. ft. at 1.0” w.g. pressure. Dampers shall be suitable for applications up to 2500 fpm velocity.
D. Description: Factory fabricated, multiple-blade, parallel action gravity type, counter-balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, synthetic bearings, and axles; adjustment device to permit setting for varying differential static pressure.
E. Frame: 0.125-inch-thick, galvanized sheet steel or extruded aluminum, with welded or jointed corners and mounting flange.
F. Blades: 0.070-inch-thick aluminum sheet.
G. Blade Seals: Neoprene or vinyl.
H. Blade Axles: Galvanized steel or extruded aluminum.
I. Tie Bars and Brackets: Galvanized steel or aluminum.
J. Adjustment Device: Adjustable counterweights or adjustable tension spring device.

2.3 MANUAL VOLUME DAMPERS

A. Approved Manufacturers:
   A. Air Balance, Inc.
   B. American Warming and Ventilating.
   C. Nailor Industries Inc.
   D. Penn Ventilation Company, Inc.
   E. Ruskin.
B. Application: Manual, non-motorized, volume dampers shall be installed in distribution ductwork to be used for balancing supply, return and exhaust volumes. For automatic modulating type control dampers for tempterature control purposes, refer to Section HVAC Controls and Instrumentation.
C. Performance: Medium and low pressure duct applications up to 2,000 fpm. Manual volume dampers are not required to have resilent seals unless being applied for shut-off service.
D. General Description: Factory fabricated, with required hardware and accessories. 3V style stiffened damper blades for stability. Include locking quadrant device to hold damper blades in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
E. Rectangular Volume Dampers: Multiple- or single-blade (9 inch height or less), opposed-blade design, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
   A. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 16 gage (0.064 inch thick), with mitered and tabbed or welded corners; frames with face flanges where indicated for attaching directly to walls and box frames where indicated for installing in ducts. Equivalent aluminum framed dampers are acceptable.

B. Roll-Formed Steel Blades: 16 gage (0.064-inch-thick), 3V style galvanized sheet steel.
C. Blade Axles: Galvanized steel.
D. Bearings: Molded synthetic.
E. Tie Bars and Brackets: Galvanized steel.
F. Pressure rating: Up to 4" wg at 2000 fpm.

F. Round and Oval Volume Dampers: Up to 24" diameter, single-blade, galvanized steel, 20 gage (0.04") blade, factory or shop fabricated damper. Provide with galvanized steel square axel, molded nylon bearings, and locking quadrant device.

G. Round Spin-In Fittings: Sheet metal conical spin-in round branch take-off complete with manual volume damper and locking quadrant. Where rectangular duct sizes do not allow a conical fitting, a straight tap shall be allowed.

H. Locking Quadrant Air Flow Balancing Device: Provide locking air-flow balancing device on all manual volume dampers. Device shall Rossi model "Everlock" type positive locking damper handle with spring-loading trigger handle with multi-postion notches for incremental air flow balancing with positive, vibration proof, setting. Standard wing-nut style locking quadrants are NOT acceptable. Include elevated 1.5" or 2" platform for insulated duct mounting. Where critical infininite air flow adjustment is noted or called for, provide a Rossi Twistknob sytle locking devices in lieu of the multi-position device.

I. Volume dampers located above ceilings and in non-accessible locations shall be equipped with Young Regulator Co. Bowden cable and worm gear assembly, with ceiling mounted adjustment assembly and stainless steel cover plate.

2.4 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
A. United McGill
B. Tuttle and Bailey
C. Air Control Products
D. Aero/Dyne.

B. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

C. Manufactured Turning Vanes: Fabricate single-vane, curved blades of galvanized sheet steel; support with bars perpendicular to blades and set into vane runners suitable for duct mounting.

D. Turning Vanes in 4" Duct Pressure Class shall be high efficiency type equal to H-E-P as manufactured by Aero/Dyne Co. constructed with 2" long airfoil leading edge and 3" long trailing edge.

E. << Hey Engineer – Consider adding/indicating Pressure Relief Doors on ducts between main AHU supply and return exhaust take-offs and closely located automatic smoke dampers (in mechanical room walls). This protects the ducts from accidental blow-outs, or collapses, if the smoke dampers inadverently close while the fans are still running. It happens!>>

2.5 PRESSURE RELIEF DOORS

A. Manufacturers:
A. Ruskin
B. Pottorff

B. General Description: Spring-load hinged access panels mounted on primary air ductwork to help prevent collapse (negative pressure door) or blow-out (positive pressure door) in the event of sudden duct closure, upstream or downstream, due to inadvertent closure of fire or smoke dampers.

C. Fabrication: Frame - 12 ga galvanized steel; Door - 12 ga galvanized steel; Seal – polyurethane foam; Springs & Hardware – brass or stainless steel.

D. Adjustable pressure relief settings from 2" to 10" w.g. positive or -4" to -10" w.g. negative.

E. Size shall be based on manufacturer's recommendation for duct airflow and pressure rating class.

2.6 DUCT/PLENUM MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   A. Elmdor.
   B. CESCO Products.
   C. Ductmate Industries, Inc.
   D. Duro Dyne Corp.
   E. McGill AirFlow Corporation.
   F. Nailor Industries Inc.
   G. Pottorff.
   H. United Enertech
B. General Description: Fabricate in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible and suitable for duct pressure class.
C. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets, quick fastening locking devices, and continuous piano hinge. For insulated ductwork, install minimum 1 inch thick insulation with sheet metal cover.
D. Less than 12 inches square: secure with sash locks.
E. Up to 18 inches square: secure with two sash locks.
F. Up to 24 x 48 inches: secure with two compression latches with outside and inside handles.
G. Access doors with sheet metal screw fasteners are not acceptable.
H. Round Duct Sandwich Type Access Doors: Fully removable dual panel door. 22 gauge galv. steel door panel construction up to 12” diameter ducts, 20 gauge for larger diameter ducts. Closed cell foam gasket. Molded poly handles with metal hardware. Rated +20” wg to -10” wg at -20 deg. F to 200 deg. F.
I. Grease Duct Sandwich Type Access Door: : Fully removable dual panel door with smooth face inner 16 ga black iron panel. 22 gauge galv. steel door panel construction up to 12”x8” door size, 20 gauge for larger size doors. Fiberglass rope gasket. Zinc coated wing nut handles with metal hardware. Rated +20” wg to -10” wg at to 1000 deg. F.
J. Door Accessories:
   A. Provide Automatic Shut off (Kill) switches on fan access doors.

2.7 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   A. Duro Dyne Corp.
   B. Ventfabrics, Inc.
B. UL listed fire-retardant neoprene coated woven glass fiber fabric and in compliance with NFPA 90A, approximately 3” wide, crimped into metal edging strip. Weight: 30 oz/sq yd.

2.8 **FLEXIBLE DUCTS**

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   A. Thermaflex
   B. Genflex
   C. Thermold
   D. Wiremold
   E. JPL
B. Up to 2” W.G. Pressure Class:
   A. Flexible duct shall be a factory assembly consisting of a spring steel helix, inner liner wrapped with 1” thick fiberglass insulation and a vapor barrier outer jacket. Composite assembly, including insulation and a vapor barrier, shall meet U.L. 181 and the Class 1 requirements of NFPA 90-A.
C. Flexible Duct Clamps: Nylon strap in sizes 3 through 18 inches to suit duct size.

2.9 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.
B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.10 OUTSIDE AIR VALVE – PRESSURE INDEPENDENT AIR CONTROLLER
A. Outside air regulator for fan coil units:
B. Manufactures:
    a. Nailor D3001 (retrofit style not allowed).
    b. Krueger (retrofit style not allowed).
C. 22 gauge galv. steel construction. Heavy gauge steel blade with polyethylene edge gasket. Damper leakage less than 1% of rated air flow at 3" w.g. Self lubricated sealed bearings. ½" drive shaft bolted to blade. Multi-point averaging air flow sensor, aluminum tubing with brass tubing connectors. NEMA 1 controls enclosure for control damper.
D. See fan coil unit schedule on drawings for sizes and quantities.

2.11 COMBINATION FIRE & SMOKE DAMPERS
A. Manufacturers:
    A. Air Balance
    B. United Enertech
    C. Nailor
    D. Pottorff
    E. Ruskin
B. General Description: Labeled according to UL 555S. Combination fire and smoke dampers shall be labeled according to UL 555 for 1-1/2-hour rating. U.L. leakage class I or II as scheduled on the drawings (leakage class III and IV are not acceptable).
C. Fusible Links: Replaceable, 165 deg F rated.
D. Frame and Blades: 0.064-inch- thick, galvanized sheet steel.
E. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.
F. Damper Operators: Two-position action.
    A. UL listed and labeled spring return electric type suitable for 120 volts, single phase, 60 Hz. Actuator shall be factory installed, normally closed.
    B. Locate damper operator on exterior of duct and link to damper operating shaft.

G. Normally Closed Smoke Responsive Fire Dampers:
H. Multi-blade type, opening by gravity upon actuation of actuator or fusible link, flexible stainless steel blade edge seals to provide constant sealing pressure.
I. Damper closure through the actuator shall be controlled to close the damper within 15 seconds through the actuator. This eliminates instantaneous closure to prevent damage to the ducts and HVAC components.

2.12 FIRE DAMPERS
A. Manufacturers:
    A. Air Balance, Inc.
    B. United Enertech
    C. Pottorff
    D. Ruskin
    E. Nailor
B. Fire dampers shall be labeled according to UL 555.
C. Fire rating: 1-1½ or 3 hours as required for installation.
D. Frame: Curtain type with blades inside airstream or with blades outside airstream as scheduled; fabricated with roll-formed, 0.034-inch thick galvanized steel; with mitered and interlocking corners.
E. Mounting Sleeve: Factory or field installed, galvanized sheet steel.

F. Minimum Thickness: 0.060 inch thick as indicated and of length to suit application.
G. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper from complies with sleeve requirements.
H. Mounting Orientation: Vertical or horizontal as indicated.
I. Blades: Roll-formed, interlocking, 0.034 inch thick, galvanized sheet steel. In place of interlocking blades, use full length, 0.034 inch thick, galvanized steel blade connectors.
J. Horizontal Dampers: Include blade lock and stainless steel closure spring.
K. Fusible Links: Replaceable, 165 deg F rated.

2.13 DUCT SILENCERS
A. Manufacturers:
   A. Industrial Acoustics Company (IAC)
   B. Vibro-Acoustics
   C. Dynasonics.
   D. Price Industries
   E. Semco
B. Duct Silencers and Sound Attenuators shall be tested in strict accordance with the 1999 ASTM E477 standard (Standard Method of Testing Duct Liner Materials and Prefabricated Silencers for Acoustical and Airflow Performance) with air flowing through the silencers, both with and against airflow. A negative face velocity implies sound transmission in the opposite direction to airflow. ASTM E477 shall have been performed in a laboratory that is NVLAP-accredited to conduct the test.
C. Duct Silencer Configuration and Performance: See Schedule on Drawings for Duct Silencer size, configuration and acoustic performance data. Basis of Design model number shall govern materials of construction, fill, lining, etc.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION
A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.
B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
C. Install gravity backdraft dampers on relief air duct nearest to outside wall where indicated.
D. Install manual balancing volume dampers in ducts with acoustic liner in a manner to avoid damage to and erosion of duct liner. Provide edge seals on duct liner before and after damper.
E. Provide manual balancing volume dampers at points on supply, return, and exhaust systems where branch take-offs lead from larger ducts as required for air balancing. If damper is not a part of a manufactured fitting, install at a minimum of two duct widths from branch takeoff.
F. Provide manual balancing volume dampers on ALL duct take-off to diffusers, grilles, and registers, regardless of whether or not separate dampers are specified as a part of the diffuser, grille, or register assembly. Locate volume damper closest to take off point, furthest from diffuser, for sound control purposes. Where volume damper locking quandrant assemblies are not accessible or are located above hard ceilings, provide a Young Regulator Co. Bowden Cable Assembly remote regulator.
G. Provide test holes at fan inlets and outlets and elsewhere as required to balance the system.
H. Install duct access doors to allow for inspecting, adjusting and maintaining accessories as follows:
   A. At motorized control dampers.
   B. At backdraft dampers.
   C. Air flow measuring stations.
   D. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.

E. As required by code on grease exhaust ducts (generally at changes in direction where duct access is not possible from in the inlet or outlet of the exhaust system).
F. Duct mounted controls or components, filters, etc. that require internal access for inspection or cleaning.

I. Duct access doors shall be installed in the largest size necessary for access or inspection of the devices served. Locate access door on face of duct most readily accessible for personnel and where clearance from adjacent building services in available.
J. Access doors on grease exhaust ducts shall be located on the tops or sides of the duct, with a minimum of 1.5” lip from the bottom edge of the duct.
K. Label ductwork according to Division 23 Section "Mechanical Identification."
L. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
M. Connect flexible ducts to metal ducts with adhesive plus draw bands.
N. Install duct test holes where indicated and required for testing and balancing purposes.
O. Connect supply air outlets to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place in locations indicated on the plan. Provide spin-in fittings to connect low pressure round ducts to rectangular ducts.
P. Install fire and combination fire & smoke dampers and ceiling radiation dampers in strict accordance with manufacturer’s directions for connections, wall mounting frames, clearances, access doors, etc. Orient smoke dampers with actuators visible and accessible for service. Coordinate power and control signal requirements with Fire Alarm Contractor.
Q. Pressure Relief Access Doors:
A. Install positive or negative pressure relief access doors on ductwork near main air handling units, where indicated on the plans, or elsewhere as required to avoid duct collapse or blow-out due to sudden loss of air pathways due to inadvertent closure of smoke or fire dampers.
R. Install duct silencers in accordance with manufacturer’s recommendations. Maintain proper minimum distances on upstream and downstream duct sections.

3.2 ADJUSTING

A. Adjust duct accessories for proper operation. Assure that all dampers rotate smoothly, all access doors are accessible and are easy to open and close. Repair or replace damaged items.
B. Adjust fire and fire-smoke dampers for proper operation. Test all smoke dampers in conjunction with the Fire Alarm System.
C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 33 00

SECTION 23 33 19 - DUCT SILENCERS

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Duct Silencers.

1.2 STANDARDS
A. Silencers shall be tested in strict accordance with the 1999 ASTM E477 standard (Standard Method of Testing Duct Liner Materials and Prefabricated Silencers for Acoustical and Airflow Performance) with air flowing through the silencers, both with and against airflow. A negative face velocity implies sound transmission in the opposite direction to airflow. ASTM E477 shall have been performed in a laboratory that is NVLAP-accredited to conduct the test.

1.3 SUBMITTALS
A. Submit under provisions of Division 23.
B. Shop Drawings: Indicate assembly, materials, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details.
C. Product Data: Test results shall be submitted to the architect and approved by the acoustical consultant to qualify for bidding. Submittals shall name the testing laboratory, date of test, dimensions of the silencer being tested, and model number. The following data shall be presented: dynamic insertion loss at each of the eight octave bands in dB, the face velocity, the static pressure drop in inches of water gauge, and the self generated sound power level in dB (re 1 pW) in each octave band.

1.4 PROJECT RECORD DOCUMENTS
A. Submit under provisions of Division 23.
B. Record actual locations of duct silencers.

1.5 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

PART 2 - PRODUCTS

2.1 DUCT SILENCERS
A. Acceptable manufactures are:
1. Price
2. Industrial Acoustics Company
3. Dynasonics
4. Vibro-Acoustics
5. Prior approved manufacturers: VAW Systems

PART 3 - EXECUTION

3.1 INSTALLATION
A. Provide duct silencers where indicated on drawings and install in accordance with manufacturer’s instructions.

3.2 COMMISSIONING
A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test

development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 33 19

SECTION 23 34 23 - POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. In-line/ceiling-mounted ventilators.
   2. Upblast and Downblast roof ventilators (non UL kitchen service).
   3. Upblast roof ventilators for Type I kitchen exhaust hood service (UL 762 Listed).
   4. Backward Inclined Centrifugal Fans - Roof Mounted Utility Sets.
   5. Dryer Booster Fans.
   6. Centrifugal Laboratory Exhaust Fans.

1.2 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
C. Field quality-control start-up test reports.
D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Roof Curbs: Where required or indicated, provide roof curb assemblies compatible with the roofing system indicted on the architectural drawings, allowing for proper pitch, with a minimum height of 12” from top of insulation level to bottom lip of fan assembly.
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. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
D. UL Standard: Power ventilators shall comply with UL 705. Power ventilators for Type I kitchen hood exhaust duty shall comply with UL 762.

1.4 PULLEYS AND BELTS

A. Allow for the complete replacement, labor and material, of pulleys and belts for all belt driven equipment as may found to be necessary during Testing and Balancing to achieve final design air flows.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved manufacturers: Unless specifically noted otherwise, the following list of manufacturers are approved to furnish power ventilators.
   1. Loren Cook Company .
   2. Acme Engineering & Mfg. Corp.
   3. Penn Ventilation.
   4. Twin City Fan

2.2 EQUIPMENT SCHEDULES

A. Refer to equipment schedules on the drawings for detailed information regarding unit designations, duty, manufacture, model number, performance, and accessories. Where the unit is specified with a defined manufacturer and model number, the characteristics and features of that specific cataloged unit shall take precedence over those indicated here. When accessories

and optional features are listed both on the drawing schedules and in the specifications, they shall be assumed to be all required.

2.3 IN-LINE / CEILING-MOUNTED VENTILATORS

A. Description: Centrifugal fans designed for installing in ceiling or for concealed in-line applications.

B. Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear the AMCA Certified Ratings Seal for Sound and Air Performance.

C. Construction: The fan housing shall be minimum 20 gauge galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 14 gauge reinforcing channel and shall be easily removable from the housing. Motor shall be mounted with vibration isolators. Unit shall be supplied with integral wiring box and disconnect receptacle. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings.

D. Fan Wheel: Wheel shall be centrifugal forward curve type, constructed of galvanized steel. Wheel shall be based balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.

E. Motor: Motor shall be open drip proof type with permanently lubricated bearings, built-in thermal overload protection and disconnect plug or ECM motor as indicated on equipment schedule/model number designation.

F. Grille for Ceiling Application: Painted metal, louvered grille with flange on intake and thumbscrew attachment to fan housing on ceiling and wall mounted fans.

G. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

H. Accessories:

1. Motorized or gravity backdraft damper as scheduled.
2. Factory fan speed control switch for direct drive models (field mounted to unit).
3. Wall or roof outlets with backdraft dampers.

2.4 UPBLAST AND/OR DOWNBLAST CENTRIFUGAL ROOF VENTILATORS

A. Description: Fan shall be a spun aluminum, roof mounted, belt driven, upblast or downblast centrifugal exhaust ventilator.

B. Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear the AMCA Certified Ratings Seal for Sound and Air Performance.

C. Construction: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The top cap shall be two piece and have stainless steel quick release latches to provide access into the motor compartment without use of tools. An integral conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Lifting lugs shall be provided. Unit shall bear an engraved aluminum nameplate.

D. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel shall be based balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.

E. Motors: Motor shall be heavy duty type with permanently lubricated sealed ball bearings.

F. Bearings: Bearings construction shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

G. Belts & Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be a precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

H. Accessories:
   1. Motorized or gravity backdraft damper as scheduled.
   2. Factory roof curb.

2.5 UPBLAST ROOF VENTILATORS (SERVING TYPE I KITCHEN HOOD)

A. Description: Fan shall be a spun aluminum, roof mounted, belt driven, upblast centrifugal exhaust ventilator.

B. Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 762). Fan shall bear the AMCA Certified Ratings Seal for Sound and Air Performance.

C. Construction: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The top cap shall be two piece and have stainless steel quick release latches to provide access into the motor compartment without use of tools. An integral conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. A one inch thick, three pound density foil back heat shield shall be utilized to protect the motor and drive components from excessive heat. Lifting lugs shall be provided. Unit shall bear an engraved aluminum nameplate.

D. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel shall be based balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.

E. Motors: Motor shall be heavy duty type with permanently lubricated sealed ball bearings.

F. Bearings: Bearings construction shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

G. Belts & Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be a precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

H. Accessories:
   1. Factory roof curb and ventilated curb extention.
   2. Factory integral grease containment system.
   3. Hinged base with locking hasps and cable restraint system.

2.6 BACKWARD-INCLINED CENTRIFUGAL FANS – ROOF MOUNTED UTILITY SETS

A. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor , drive assembly, and support structure.

B. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
   1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   2. Spun inlet cone with flange.
   3. Outlet flange.
   4. Door Accessories:
      a. Provide Automatic Shut off (Kill) switches on fan access doors.

C. Backward-Inclined Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate and fastened to shaft with set screws.

D. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   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.
E. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
   1. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000 hours.
   2. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.
F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.2.
   2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
   6. Motor Mount: Adjustable for belt tensioning.
G. Accessories:
   1. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
   2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
   3. Spark-Resistant Construction: AMCA 99.
   4. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
   5. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
H. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Enclosure Type: Totally enclosed, fan cooled.

2.7 DRYER BOOSTER FANS
A. Manufacturers:
   1. Fantech
   2. AXC
   3. Or approved equivalent.
B. Certifications: Unit shall be UL and CSA listed.
C. Warranty: Unit shall have a five year warranty.
D. Features:
   1. Inline dryer booster fan shall be capable of maintaining an air velocity of 1200 fpm with an equivalent duct length of 130 feet of 4 inch rigid steel duct.
   2. Unit shall include remote-mount, low voltage indicator panel capable of displaying: normal operation, no power, blocked duct, locked motor rotor and low speed conditions.
   3. Unit shall be capable of exhausting air up to 140 degrees F.
   4. Motor shall be a permanently lubricated, enclosed external rotor design.
   5. The blower wheel shall be a self cleaning backward curved impeller design.
   6. The dryer booster fan shall have a galvanized steel housing with powder coat finish.
   7. A 50 foot cable shall be provided to field connect the remote mount indicator panel to the dryer booster fan.
   8. Unit shall be provided with a 5.5 foot long 120 Vac power cord.
   9. Unit shall be provided with inlet and outlet flanges for connection to rigid duct.
   10. Unit shall be provided with mounting bracket and hardware.
   11. Unit shall be provided with 18" of pressure sensing tubing with mounting grommet to be field installed.

E. Operation:
1. When the associated clothes dryer is activated the dryer booster fan unit's pressure sensing switch automatically turns the fan on.
2. The dryer booster fan monitors the status of the dryer and will turn itself off when the dryer stops.

2.8 CENTRIFUGAL UTILITY SET TYPE LABORATORY EXHAUST FANS

A. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor , drive assembly, and support structure.

B. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Spun inlet cone with flange.
3. Outlet flange.
4. Door Accessories:
b. Provide Automatic Shut off (Kill) switches on fan access doors.

C. Backward-Inclined Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate and fastened to shaft with set screws.

D. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
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.

E. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
1. Bearing Rating Life: L50 at 200,000 hours.

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
1. Service Factor Based on Fan Motor Size: 1.2.
2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
6. Motor Mount: Adjustable for belt tensioning.

G. Accessories:
1. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Type B Spark-Resistant Construction: AMCA 99.
4. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
5. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

H. Curb Cap & Plenum Assembly:
1. Integral bottom inlet curb cap and low-loss elbow plenum assembly.
2. Plenum box with removable, gasketed access door with quick release latches for wheel and duct cleaning.
3. Provide with integral backdraft damper assembly.

I. Lab Exhaust Discharge Hood:

1. Provide fan assembly with upblast discharge hood/nozzle assembly with adjustable hinged damper to allow variations in throat area for maximizing exit velocity and plume height.

2.9 TUBULAR CENTRIFUGAL UPBLAST TYPE LABORATORY EXHAUST FANS

A. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven tubular centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor , drive assembly, and support structure.

B. Housings: Min. 12 gauge welded steel housing, with doors or panels to allow access to internal parts and components.
   1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   2. Outlet flange with guy-wire support points.
   3. Door Accessories:
      c. Provide Automatic Shut off (Kill) switches on fan access doors.

C. Backward-Inclined Wheels: Backward inclined, non-overloading welded aluminum wheel construction.

D. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   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.

E. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
   1. Bearing Rating Life: L10 at 100,000 hours.
   2. Stainless steel lube lines.

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.2.
   2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
   6. Motor Mount: Adjustable for belt tensioning.

G. Accessories:
   1. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
   2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
   3. Type B Spark-Resistant Construction: AMCA 99.
   4. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
   5. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

H. Mixing Box & Plenum Assembly:
   1. Integral bottom inlet roof curb plenum assembly with mixing box bypass damper inlet hood and damper.
   2. Plenum box with removable, gasketed access door with quick release latches for damper access and duct cleaning.
   3. Provide with integral backdraft damper assembly.

I. Lab Exhaust Discharge Nozzle Cone:
   1. Provide fan assembly with upblast discharge tapered conical nozzle assembly for maximizing exit velocity and plume height.

2.10 MOTORS

A. Comply with the requirements of the Washington State Energy Code for motor efficiencies.
B. Frational horsepower motors shall be ECM type in accordance with the WA Energy Code, unless specifically indicated otherwise.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators and exhausters generally where indicated on the plans. Coordinate location with nearby equipment and building elements.
   1. Locate all exhaust outlets a minimum of 10 feet from air intakes or greater as indicated on the drawings.
B. Install power ventilators level and plumb.
C. Ceiling Units: Suspend units from structure; use steel wire or metal straps. Flash and caulk weather tight around all wall or roof outlet hoods.
D. Support suspended In-Line units from structure using threaded steel rods. Vibration-control devices are specified in Division 23 Section "Mechanical Vibration Controls."
E. Install roof mounted ventilators on roof curbs or platforms, plumb and level. Install neoprene gaskets between fans and curbs. Anchor to curbs in accordance with manufacturer's instructions. Provide guy wires and anchors on all exhaust assemblies and discharge hoods taller than 6 feet above roof level or as otherwise indicated.
F. Install units with adequate clearances for service and maintenance.
G. Label units according to requirements specified in Section 23 0553 – Identification for HVAC Piping and Equipment.
H. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 3300 - Duct Accessories.
I. Ducts installed adjacent to power ventilators shall be done in a manner that allows service and maintenance.
J. Ground equipment according to Division 26, Section "Grounding and Bonding for Electrical Systems."
K. Connect wiring according to Division 26, Section "Low Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Verify lubrication for bearings and other moving parts.
   5. Verify that manual and automatic volume control in connected ductwork systems are in fully open position.
   6. Remove and replace malfunctioning units and retest as specified above.
B. Test and adjust controls,safeties and backdraft dampers. Replace damaged and malfunctioning controls and equipment.
C. Provide start-up and testing report for each power ventilator. Furnish report to Commissioning Agent and provide copy in O & M manual.
D. Make any fan speed adjustments and replace pulleys and belts as directed by the Testing & Balancing Contractor.

END OF SECTION 23 34 23

SECTION 23 34 24 - HIGH VOLUME LOW SPEED CEILING FANS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes high volume low speed ceiling mounted circulation fans.

1.2 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, accessories, and color option for each unit indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Field quality-control test reports.

D. Operation and maintenance data.

E. Warranty as specified in this section.

1.3 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. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

1.4 WARRANTY

A. Provide a 10-year warranty on motor, gearbox and controller including labor, travel costs and living expenses to repair or replace products and systems within the first 12 months of service. Lifetime warranty on blades, hub and mounting system.

PART 2 - PRODUCTS

2.1 HIGH VOLUME LOW SPEED CIRCULATION FANS

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

B. Delta T Corp (d.b.a. Big Ass Fans)

C. MacroAire

D. Entrematic.

E. Description: Ceiling mounted, high volume low speed circulation fan with direct drive and variable speed controls to provide silent operation. Fan equipped with factory provided and mounted light.

F. Construction: Blades: Extruded alumumin airfloil blades connected to the hub with locking bolts. The tip of each blade shall be fitted with winglets to redirect horizontal airflow to vertical flow.

G. Hub: Aluminum construction and shall incorporate safety devices that will secure the hub/airfoil assembly in case of shaft failure.

H. Motor: Permanent magnet brushless motor rated for continuous operation at maximum speed with the capability of modulating the fan speed from 0-100% through a variable speed drive. The motor shall operate from the voltage scheduled on the drawings. The motor shall be a non-ventilated, heat sink design.

I. Mounting System: Shall be designed for installation from a structural support beam or to wood roof deck. Manufacturer shall include mounting details specific to the project details as part of their submittal. Where attaching to wood roof deck, All components in the mounting system shall be of welded steel construction and powder coated.

J. Safety Cables: The fan shall be equipped with factory constructed safety cables to additional means of securing the fan assembly to the building structure and the motor unit to the mounting system.

K. Controls: The variable speed drive and controller shall be incorporated into the fan assembly and housed in an enclosure. A wall mounted controller shall be provided which will provide an LCD screen user interface for controlling direction and speed of multiple fan units from a single wall controller. Ethernet communication between the wall controller and the fans shall be field installed by the BAS controls contractor. The wall controller shall include a simple diagnostic program to identify faults in the system and shall interface with the DDC building automation system to provide fan status to the workstation.

L. Capacities: See equipment schedules on drawings.

M. Accessories: Provide no-ass package (do not display brand name).

PART 3 - EXECUTION

3.1 INSTALLATION

A. The fan shall be mounted to an angle iron or I-beam structure or to a wood roof deck surface. Consult the Installation Guide for acceptable I-beam width, and proper sizing and placement of angle iron for a span mount. Where attached to the roof deck, coordinate with the architect prior to roof insulation being applied. A structural engineer shall be consulted for installation methods outside the manufacturer's recommendation and a certification submitted prior to installation. The design criteria for the fan mounting system shall be capable of handling 300 ft·lbs (407 N·m) of torque.

B. The fan shall be installed so that the airfoils are at the height above the floor indicated on the plans, but not less than 3-ft below the roof. The fan installation area shall be free of obstructions such as lights, cables, sprinklers or other building structures; with the airfoils at least 2-ft clear of all obstructions.

C. If the fan is hung from an extension tube that measures 4' (1.2 m) or longer, it may be necessary to provide guy cables or struts to limit potential lateral movement of the fan. A stiffening strut braced against an additional beam may be required if there is a close clearance situation.

D. In order to comply with the National Fire Protection Association® (NFPA®) guidelines for sprinkler systems (NFPA 13), all HVLS fans shall incorporate a means of automatic shutdown upon detection of water flow in the sprinkler system.

E. Big Ass Fans installed in buildings that are equipped with sprinkler systems, including Early Suppression Fast Response (ESFR) sprinklers, shall comply with the following guidelines to adhere to the National Fire Protection Association (NFPA) standards:

F. Each fan shall be centered between four (4) adjacent sprinklers.
   1. The vertical distance from the fan to the sprinkler deflector shall be a minimum of three (3) ft.
   2. All fans shall be interlocked to shut down immediately upon receiving water flow signal from the alarm panel.

END OF SECTION 23 34 24

SECTION 23 35 19 - FUME EXTRACTION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
- A. This Section includes:
  1. General Fume Exhaust Hoods.
  2. Fume Extraction Arms.
  3. Overhead Boom Type.

1.2 REFERENCES
- A. ASTM International:
  1. ASTM A36 – Standard Specification for Carbon Structural Steel.
  2. ASTM A123 – Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
  3. ASTM A480 – Standard Specification for General Requirements for Flat Rolled Stainless and Heat Resisting Steel Plate, Sheet, and Strip.
  4. ASTM A666 – Standard Specification for Annealed or Cold Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
- B. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
  1. SMACNA "HVAC Duct Construction Standards – Metal and Flexible."
  2. SMACNA "Kitchen Equipment Fabrication Guidelines."
- C. Specialty Steel Industry of North America (SSINA)

1.3 SUBMITTALS
- A. Product Data: For the following:
  1. Fabrication shop drawing for canopy hoods.
  2. Product data.
  3. Electrical characteristics and wiring diagrams.
  4. Operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUME EXTRACTION ARMS
- A. Swivel Extraction Arm
  1. Three-Joint Articulated Fume Arm Assembly.
  2. Flexible Hose: The external flexible hose shall be made of a woven glass fabric with and internal and external PVC lamination. The hose shall be supported be a spirally wound wire helix. The hose shall be capable of withstanding a maximum operating temperature of 158°F. The flexible hose shall be 6.25" diameter.
  3. Friction Joints: All articulating joints shall incorporate friction discs and be adjustable for tension. Friction discs shall be made of an asbestos free brake lining material. All friction joints shall utilize hardware incorporating nylon lock nuts.
  4. Mounting Brackets: A wall mounting bracket shall be included with each fume arm. The wall bracket shall be formed from 1.25" diameter x 0.095" thick tubular steel. The wall bracket shall be predrilled to match the bolt pattern of the arm.
  5. Intake Integral Hood: Intake cone with universal pivot joint and 65-watt halogen light.
- B. Manufacturers:
  1. Ventaire
  2. Air Flow Systems.

3. AQC Dust Collecting Systems.
4. NSGV
5. Prior approved equal.

2.3 OVERHEAD BOOM EXHAUST SYSTEMS

A. Manufacturers:
   1. AQC Dust Collecting Systems.
   2. NSGV.
   3. Prior approved equal.

B. Pivoting Boom Arm:
   1. The boom arm shall be a truss style design constructed of heavy gauge tube steel welded together to form a rigid structure. The boom shall be provided with a pivoting wall bracket constructed of a one-piece die formed steel plate. A hard duct cradle shall be provided on top of the boom. Connection from the hard duct on the boom to the exhaust duct shall be with flexible duct.
   2. Hose reel balancer cable retractor and saddle.

C. Flexible Exhaust Hose:
   1. Hose to be asbestos-free flexible fiberglass material with an outer metal helical ring to provide support. Hose operating temperature shall be adequate for the type of service it is being used in but no less than 600 deg. F.

D. Inlet Nozzle:
   1. Inlet cone with handle, shutoff damper and mesh screen.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct and accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Provide balancing dampers at points on exhaust systems where branches lead from larger ducts as required for air balancing. If damper not a part of a manufactured fitting, install at a minimum of two duct widths from branch takeoff.

D. Provide test holes at fan inlets and outlets and elsewhere as required for testing and balancing the system.

E. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories.

F. Label access doors according to Section 23 05 53 - Identification for HVAC Piping and Equipment.

3.2 ADJUSTING

A. Adjust accessories for proper settings.

B. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 35 19

SECTION 23 37 13 - AIR OUTLETS AND HOODS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes ceiling and wall mounted diffusers, registers, grilles and roof mounted hoods.

1.2 SUBMITTALS

A. Product Data: For each product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 AIR OUTLETS

A. Registers, grilles and ceiling diffusers, shall be furnished in standard white unless noted otherwise on schedule. All diffusers shall meet performance of the specified Titus diffusers. See schedule for model numbers and types. Prior approvals shall be accompanied with performance data and return grille sample.
B. Diffusers scheduled to be installed in suspended ceiling shall fit within grid system and rest evenly on tees within the specified grid. See Architectural plans for type of suspended ceiling system.
C. Diffusers, grilles and registers to be installed in rated ceiling assemblies shall be provided with radiation dampers. Refer to Div. 23 Section “Duct Accessories”.
D. Manufacturers:
   1. Titus.
   2. Krueger.
   3. Nailor Industries.
   4. Price Industries.
   5. Tuttle & Bailey

2.3 WEATHER LOUVERS

A. Provide profile and finish to match architectural profile specified in Section 07 4213 – Ribbed Metal Wall Panels. Coordinate with metal wall panel manufacturer to provide clean appearance in transition from louver to panel, including additional shop drawings and profile samples prior to fabrication.
B. Louvers shall be fabricated aluminum construction and furnished with ½” mesh, galvanized interior bird screens.
C. Provide profile and finish to match architectural profile of the Centria Concept Series concealed fastener panels CS-260. Color shall be pewter.
D. Submittals for louvers shall include complete performance data for free area and pressure drop. Moisture penetration performance, AMCA rated, shall be submitted for louvers.
E. Louvers shall have 16 gauge channel steel frames and extended sill drip troughs. Blades shall be 20 gauge steel, drainable design, at 35 degrees with 3 ½” spacing. Jambs shall include integral downspouts for carrying water from louver blades to llouver still.

F. Louvers shall pass 1100 FPM free area velocity with less than .15" wg pressure drop and shall carry less than .01 ounces of water per square foot during a 15 minute period when tested in accordance with AMCA Standard 500. Test criteria shall be based on a 48" square sample.
G. Louvers shall bear the AMCA Certified Ratings Seal for both Air Performance and Water Penetration. See schedule for additional information.
H. Blank-Off Panels: "BLNK-X" Insulated Blank-Off Panels by R&S Manufacturing and Sales or prior approved equal. Insulated blank-off panel shall be designed to mount on the rear of the louver face secured by factory installed J-clip brackets. Panels shall be removable.
   1. Panel Skins: 0.063 inch aluminum pans mechanically fastened.
   2. Insulation: 2" fire-rated, closed-cell polyisocyanurate (polyiso) foam core with aluminum foil facer.
   3. Performance: 13.1 R-Value
   4. Finish: To match weather louver panel
   5. Bracket Assembly: 0.063" thick aluminum, mechanically fastened to louver.
   6. Fasteners: Manufacturer's recommended fasteners.
I. Manufacturer:
   1. Pottorff
   2. Ruskin
   3. American Warming and Ventilating Co.
   4. Air Balance
   5. Louvers and Dampers, Inc.
   6. United Enertech

2.4 ROOF HOODS
A. Gravity roof ventilators shall be constructed of heavy gauge aluminum.
B. Hoods shall be constructed of precision formed, arched panels with interlocking seams.
C. Bases shall be constructed so that the curb cap is 8" larger than the throat size. Base height shall be 12".
D. Hood support members shall be constructed of galvanized steel and fanstened so that the hood can be hinged open.
E. Birdscreens constructed of ½" galvanized steel mesh shall be mounted horizontally across the intake/discharge area of the hood.
F. Manufacturer:
   1. Price
   2. Ruskin
   3. American Warming and Ventilating Co.
   4. Air Balance
   5. Louvers and Dampers, Inc.
G. Other roof outlets, such as dryer vents and residential range hood vents, shall be either pre-manufactured assemblies or field fabricated as indicated. Provide with roof flashing assemblies and install a minimum of 12" above roof deck for snow accumulation clearance.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install diffusers, registers, grilles and louvers level and plumb. Provide square-to-round transitions on supply air diffusers where required to connect to round flexible ducts. Connect flex duct to plenum with nylon drawbands.
B. Ceiling Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers. Seal exhaust and return grilles to riser ducts in a manner that does not allow ceiling plenum air to bypass in to duct connections.
D. Install manual volume dampers on all supply air grilles and exhaust air grilles with scheduled air volumes (locate at branch duct take-offs, not at diffuser). Where volume dampers are not accessible through ceiling, install remote, ceiling mounted regulator assemblies. Return air and relief air grilles with variable air flow volumes do not require volume dampers unless otherwise noted.
E. Diffusers, registers and grilles installed in rated ceiling assemblies shall be provided with radiation dampers and non-asbestos thermal insulation blanket on portion of grille that extends beyond grille face (i.e. T-bar ceilings)
F. Locate and place roof hoods and vents level, plumb, and at indicated alignment with adjacent work. Provide roof curbs and/or flashing assemblies.
G. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
H. Repair damaged finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
I. Paint visible surfaces behind air outlets flat black.
J. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
K. Install Louvers per manufacturers requirements.

3.2 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing. Readjust air patterns if necessary, after air balancing, in order to avoid drafts or other objectionable air motion.

3.3 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 37 13

SECTION 23 41 00 - AIR FILTERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.
   1. Filters for air handling equipment. Coordinate with air handling unit manufacture to provide standard sizes and types of filters for all units.

1.2 REFERENCES

A. ASHRAE
   2. ASHRAE 52.1 – Air Filter Standard, Dust Spot Efficiency
   3. ASHRAE 52.2 – Air Filter Standard, Average Arrestance
B. ANSI/ARI 850 – Standard for Performance Rating of Commercial and Industrial Air Filter Equipment.
C. National Fire Protection Association:
   4. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems.
   5. NFPA 90B – Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
D. Underwriter Laboratories (UL), Inc.

1.3 SUBMITTALS

A. Product Data: Include dimensions; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each unit indicated.
B. Shop Drawings:
   6. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Comply with ARI 850.
B. Comply with ASHRAE 52.1 and ASHRAE 52.2 for method of testing and rating air-filter units.
C. Comply with NFPA 90A and NFPA 90B.

PART 2 - PRODUCTS

2.1 FILTERS

A. General:
   1. Filters:
      a. Filters shall be listed and rated as Class 2 by Underwriters Laboratories, Inc.
      b. A complete set of filters shall be supplied for use during construction. A complete set of new filters shall be installed immediately before testing and balancing. Total of two sets for each type of filters listed.
   2. Filter Media & Frames:
      a. Rigid Frame with Media support Grid (Medium & High Efficiency Filters):
         1) Filter media: Pleated Cotton and synthetic blend.
         2) Media support grid: Welded wire on 1” centers with an open area not less than 96%.
            a) Bond grid to media to eliminate oscillation and pull away.
            b) Form grid to affect a radial pleat, allowing total use of media.
         3) Frame: Rigid, high wet-strength beverage board, with diagonal support members bonded to the air entering and air exiting side of each pleat.

b. Rigid Frame with Media Blanket bonded to Frame (High Efficiency Filters):
    1) Filter media: Pleated microfine glass media in a uniform high loft media blanket with a synthetic micro mesh media backing.
    2) Media blanket: Formed into uniform tapered radial pleats and bonded to a stiffened backing that is bonded to the downstream side of the media to preclude media oscillation.
    3) Frame: Corrosion resistant galvanized steel. The media pleat configuration shall be maintained by bridge style plastic contour stabilizers. Minimum of four contour stabilizers on the air entering side and four on the air exiting side.
        a) Media to be mechanically and chemically bonded within the frame to prevent air bypass.
c. Wet Duty Filters & Frames:
    1) Filter media: 100% Synthetic pleated media that will not absorb moisture and maintains its integrity even in wet conditions. Synthetic spacing bands and polyurethane seals on both ends for strengthening of V-shaped pleats. No metal parts for corrosion proof design.
    2) Frame: Durable plastic frame to resist moisture, warming and microbial growth.
    3) Rated UL Class 1.
    4) Equal to Viledon (Freudenberg Technologies) Mini Series (Mini RF = MERV 7, Mini 85 = MERV 13).
d. Coordinate with AHU/HRU/FC manufacturer for filter and frame mounting styles to be compatible with AHU filter frame and service access (side or front load).

3. Manufacturers:
    a. Camfil Farr
    b. Flanders
    c. Or approved equal.

B. Air Handling Units, DOAS Units:
1. Pre Filters
    a. Medium Efficiency Pleated Filters. Basis of Design: Camfil Farr 30/30.
    b. Minimum MERV rating 8 (30 - 35%) efficiency, when tested in accordance with ASHRAE 52.2.
    c. Initial resistance shall not exceed 0.23” w.g. (1” thick @ 350 fpm), 0.31”w.g. (2” thick @ 500 fpm), 0.31”w.g. (4” thick @ 500 fpm)
    d. 1”/2”/4” thick, pleated disposable type air filters, limited to the two following sizes:
        1) 12” W x 24” H.
        2) 24” W x 24” H.
    e. Rigid Frame with Media support Grid, as specified above.
2. Second Stage Filters
    a. High Efficiency Pleated Filters. Basis of Design: Camfil Farr Opti-Pac.
    b. Minimum MERV rating 13 (80 - 90%) when tested in accordance with ASHRAE 52.2.
    c. Initial resistance at 500 fpm shall not exceed 0.47” w.g.
    d. 4” thick, pleated disposable type air filters, limited to the two following sizes:
        1) 12” W x24” H.
        2) 24” W x24” H.
    e. Rigid Frame with Media Support Grid, as specified above.
3. After Filters (DOAS Only):
    a. High Efficiency Pleated Filters. Basis of Design: Camfil Farr Riga-Flo.
    b. Minimum MERV rating 13 (80 - 90%) when tested in accordance with ASHRAE 52.2.
    c. Initial resistance at 500 fpm shall not exceed 0.50” w.g.
    d. Filters shall be 12” thick and be limited to the two following sizes:
        1) 12” W x24” H.
        2) 24” W x24” H.
    e. Rigid Frame with Media Blanket bonded to Frame, as specified above.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Utilize contractor furnished temporary construction filters during building construction, start-up and testing. Provide clean, new permanent filters upon system acceptance at Substantial Completion, provided area is complete and free of drywall or painting work.

B. Final, clean, permanent filters shall be in place for testing and balancing work. If the areas served are not clean and complete per above, the contractor shall utilize equivalent (size and rating) clean temporary construction filters during TAB activities.

C. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

D. Install filters in position to prevent passage of unfiltered air.

E. Coordinate filter installations with duct and air-handling unit installations.

END OF SECTION 23 41 00

SECTION 23 51 00 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SUMMARY
- A. This Section includes the following:
  1. Listed double-wall vents.
  2. Combustion Air intake piping.

1.2 SUBMITTALS
- A. Product Data: For the following:
  1. Type Category III or Special BH vents.
- B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

PART 2 - PRODUCTS

2.1 LISTED TYPE CATEGORY III AND BH VENTS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Flex-L Inc.
  2. Heat-Fab, Inc.
  3. Metal-Fab, Inc.
  4. ProTech Systems, Inc.
  5. Z-Flex, Inc.
  6. Schebler
- B. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F. continuously, with positive or negative flue pressure complying with NFPA 211.
- C. Construction: Inner shell and outer jacket separated by at least 1/2-inch airspace.
- D. Inner Shell: ASTM A 959, Type 29-4C stainless steel.
- E. Outer Jacket: Stainless steel.
- F. Accessories: Tees, elbows, increasers, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
  1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.

2.2 COMBUSTION AIR INTAKE VENTS
- A. For sealed combustion appliances, water heaters and boilers, provide Schedule 40 CPVC piping with solvent weld fittings and joints, unless otherwise required by appliance manufacturer.

PART 3 - EXECUTION

3.1 APPLICATION
- A. Listed Type Category III and BH Vents: Vents for high efficiency condensing gas-fired boilers and water heaters.
- B. CPVC combustion air vents: Intake pipes for high efficiency, sealed combustion appliances.
- C. Coordinate vent size, arrangement, maximum allowed length with actual appliance installed, which may vary from basis of design appliance, and provide proper installation at no additional cost to the Owner. Drawings indicate the basis of design application, which need to be verified with actual installed appliance.

3.2 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
B. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
C. Lap joints in direction of flow.
D. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
E. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
F. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.
G. All seams and joints without gaskets must be sealed with high-heat resistant silicone sealant or UL listed aluminum adhesive tape having a minimum temperature rating of 350°F.

3.3 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 51 00

SECTION 23 52 16 - CONDENSING HOT WATER BOILERS

PART 1 - GENERAL

1.1 SUMMARY
- A. Section Includes:
  1. Condensing copper tube boilers.

1.2 REFERENCES
- A. Underwriters Laboratories:
  1. UL 795 - Commercial-Industrial Gas Heating Equipment.
- B. American Society of Mechanical Engineers:
  1. ASME Section IV - Boiler and Pressure Vessel Code - Heating Boilers
  2. ASME CSD-1 – Controls and Safety Devices for Automatically Fired Boilers
- C. Hydronics Institute Boiler Testing Standards:
  1. BTS-2000 – Method to Determine Efficiency of Commercial Space Heating Boilers.
- D. National Fire Protection Association:
  1. NFPA 54 - National Fuel Gas Code.

1.3 SUBMITTALS
- A. In accordance with Contract Documents.
- B. Product Data: Submit capacities and accessories included with boiler. Include general layout, dimensions, size and location of water, fuel, electric, air inlet and vent connections, electrical characteristics, weight and mounting loads. Provide wiring diagrams that are specific to this project.
- C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

1.4 CLOSEOUT SUBMITTALS
- A. In accordance with Contract Documents.

1.5 QUALITY ASSURANCE
- A. Boiler
  1. Construction shall conform to ASME Section IV and UL 795. The boiler shall bear the ASME “H” stamp and be National Board Listed for 160 psi working pressure and 250°F.
  2. Gas Train and Safety Controls: Conform to requirements of UL 795 and CSD-1.
- B. Provide services of manufacturer's authorized and factory-trained representative to perform the following functions:
  1. Inspect and verify installation.
  2. Checkout and startup/supervision. Submit startup report.

1.6 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section.
- B. Installer: Company specializing in performing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING
- A. In accordance with Contract Documents.
- B. Accept equipment and accessories on site in factory shipping packaging. Inspect for damage.
- C. Protect equipment from damage by leaving packing in place until installation.
- D. Equipment must be protected from inclement weather, flooding, electrical surges, etc.

1.8 WARRANTY
- A. Boiler shall have the following warranties;
  1. The primary copper-fin tube heat exchanger shall carry a 5-year limited warranty, and a 20-year warranty against thermal shock.

2. The secondary 316L heat exchanger shall carry a 3-year limited warranty.
3. The burner shall carry a 10-year limited warranty.
4. All other parts shall have a 1-year limited warranty.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to installation.

1.10 START-UP OF EQUIPMENT

A. Operating and Maintenance Instructions are to be furnished with each unit.
B. The boiler shall be factory assembled and fire tested requiring only connections to the water circulating system (supply & return), fuel, electrical power, exhaust vent and air inlet (as specified/shown in contract drawings).
C. Factory-authorized representatives shall perform start-up service on each unit.

1.11 MAINTENANCE SERVICE

A. Furnish service and maintenance of boiler for one (1) year from date of start-up, not to exceed eighteen (18) months from date of shipment.
B. Maintenance service shall be performed by qualified personnel under supervision of a trained owner representative.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Cleaver Brooks Boiler, ClearFire Model CFCE-4000. Refer to the Equipment Schedule in the Contract Drawings for the specific criteria.
B. Lochinvar Knight Series. Refer to the Equipment Schedule in the Contract Drawings for the specific criteria.

2.2 GENERAL REQUIREMENTS

A. Boiler
1. Factory-packaged unit, complete with jacket, gas manifold, burner and controls mounted and wired, as specified in this Section.
2. The complete boiler shall be factory fire tested by the manufacturer and a copy of the fire test report shall be supplied with the unit.
3. The primary heat exchanger shall be constructed in accordance with Section IV of the ASME code, with straight, integral copper-finned tube construction and a gastketless header at top and bottom.
4. The primary heat exchanger design must allow for access and replacement of each individual tube.
5. The wall thickness of the primary heat exchanger tubes shall be no less than 0.072” with fin spacing of no less than 7 fins per inch.
6. The heat exchanger shall encompass the entire burner and be enclosed in stainless steel with a fully water-backed tube sheet.
7. Each boiler shall be contained in a minimum 16-gauge negative pressure steel jacket protected with a powder-coated finish. The unit shall be able to operate with any jacket panels removed during inspection or maintenance periods.
8. The total heat exchanger surface shall be no less than 6.6 square foot per BHP.

B. Fuel Burning System
1. Radiant non-corroding ceramic burner, with no moving parts. Double-meshed screen, fiber-metal mats, aluminized or stainless steel construction of the burner will not be accepted.
2. Burner operation shall be Full Modulation with minimum 3:1 turn down utilizing a VFD and air-fuel ratio valve for dependable, repeatable modulation. Dampers, linkages or a one-speed fan are not acceptable.

3. Interrupted-type mixed fuel/air pilot system with electric spark-to-pilot ignition that utilizes a UV scanner to prove pilot before main gas valves open. Hot surface ignition systems are not acceptable.
4. The entire firing control sequence shall be monitored by a UL approved, commercial-type microprocessor flame safeguard programmer with first out fault annunciation and diagnostic indicator lights. Furnish pre-purge and post-purge timing. Shut down burner in the event of ignition pilot and/or main flame failure with manual reset. It shall also recognize the Proof of Closure switches on the gas valves (if DB&B w/POC).
5. Full frontal access port shall be provided for the control area.
6. The boiler will be equipped with a non-sparking blower manufactured with a cast aluminum housing.
7. Combustion air pressure switch shall be provided.
8. The blower shall be equipped with a replaceable combustion air filter, 99% efficient to one micron. The unit will have the capability of sealed, direct, or conventional venting. Air inlet dampers and vacuum relief dampers are not required for proper operation.
9. The noise level rating for a single boiler at full fire shall be no more than 60 dB.

C. Gas Train
1. Gas train shall be UL/FM/CSD-1 compliant.
2. The gas train shall be certified to take a maximum of 5 psi Natural Gas [2 psi Propane (LP)]. Additional step-down regulators are not allowed and can cause nuisance shutdowns of the unit.
3. Pilot and main gas pressure regulator.
4. Automatic main and redundant gas valves.
   a. Motorized automatic main and redundant gas valves and a normally open vent valve in between (if DB&B).
5. Leak test valves downstream of each gas valve.
6. High and low gas pressure switches.
7. Manual shut off valve upstream of burner and downstream of last gas valve.

D. Electrical Input
1. Electrical input to each boiler shall be 120v/1ph/60Hz. Single-point electrical hook-up on every unit is required; separate power wiring and control wiring is not acceptable.
2. The boilers must utilize a commercial quality 120v/1ph control system voltage. A residential type 24v control system is not acceptable.

E. Water Trim and Controls
1. ASME rated pressure relief valve set at 75 psig.
2. Combination water pressure and temperature gage. Furnish graduated pressure gauge scale from 1-1/2 to 3 times of pressure relief valve setting.
3. A water flow switch to prevent burner operation during low water flow conditions.
4. An adjustable high limit temperature controller with manual reset to prevent water temperature from exceeding a safe system temperature.
5. An adjustable operating temperature controller.

F. Venting
1. It shall be AL29-4C, positive pressure type vent material. Single wall vent is acceptable where allowed by local code.

G. Air Intake Piping
1. It can be PVC or galvanized smoke pipe that is sealed and pressure tight. Pipe must be at least the same size as the connection on the unit.
2. Intake dampers and vacuum relief dampers are not required for sealed combustion/direct venting. Vacuum relief dampers can violate the intent of sealed combustion/direct vent applications.

2.3 PERFORMANCE

A. The boiler shall have a minimum of 97% thermal efficiency as listed in the Equipment Schedule of the Contract Documents.

B. The boilers must have third party (BTS-2000) certification of efficiency and documentation to be supplied to engineer and owner.

C. All condensing in the boiler shall take place in a secondary heat exchanger. The secondary heat exchanger material shall be made of 316L stainless steel. Proper condensate removal provisions shall be incorporated in the design to remove all condensate from the unit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the boiler in accordance with manufacturer's printed instructions.
B. Install skid plumb and level, to plus or minus 1/16 inch over base.
C. Maintain manufacturer's recommended clearances around and over equipment, and as required by local Code.
D. Arrange all electrical conduit, piping, exhaust vent, and air intake with clearances for burner removal and service of all equipment.
E. Connect exhaust vent to boiler vent connection, full size of outlet.
F. If shown in Contract Drawings, connect full sized air inlet vent to flanged connector on boiler.
G. Connect fuel piping in accordance with NFPA 54.
H. Connect fuel piping to unit, full size, at gas train inlet.
I. Use full size (minimum) pipe/tubing on all gas vent connections.
J. Connect water piping, full size, to supply and return connections.
K. Install all piping accessories per the details on the contract drawings.
L. Install discharge piping from relief valves and drain valves to nearest floor drain.
M. Connect appropriate electrical power to the boiler.
N. A dedicated disconnect shall be provided for each individual piece of equipment.

3.2 FIELD QUALITY CONTROL

A. Provide services of manufacturer's authorized representative as specified in this Section.
B. Perform combustion test including boiler firing rate, gas flow rate, heat input, burner manifold gas pressure, percent carbon monoxide, percent oxygen, percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output. Perform test at minimum, mid-range, and high fire.

3.3 CLEANING

A. MUST isolate boiler when any cleaning or testing of system piping is being performed.
B. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start-up instructions.

3.4 DEMONSTRATION

A. Demonstrate operation and maintenance procedures for a time period of 8 hours.
B. Furnish services for manufacturer's technical representative, as specified.

3.5 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 52 16

SECTION 23 64 26 - AIR COOLED CHILLERS

PART 1 - GENERAL

1.1 SUMMARY
- A. This section includes design, performance criteria, refrigerants, controls, and installation requirements for air-cooled rotary screw compressor packaged chillers.

1.2 REFERENCES:
- A. Comply with applicable Standards/Codes including ARI 550/590, ARI 370, ANSI/ASHRAE 15, ASME Section VIII Div 1 and NEC.
- B. Equipment efficiency shall meet Washington State Non-residential Energy Code and ASHRAE Standard 90.1.

1.3 SUBMITTALS:
- A. Submit shop drawings and product data in accordance with contract specification requirements.
- B. Submittals shall include the following:
  1. Dimensioned plan and elevation view drawings, required clearances and location of all field connections.
  2. Summary of all auxiliary utility requirements such as electricity, water, compressed air, etc. Summary shall indicate quality and quantity of each required utility.
  3. Single line schematic drawing of the power field hookup requirements, indicating all items that are furnished
  4. Schematic diagram of control system, indicating points for field connection. Diagram shall fully delineate field and factory wiring.
  5. Certification of factory run test with evaporator water flow, signed by company officer.
  6. Installation and operating manuals.
- C. Source quality-control test reports.
- D. Startup service reports.
- E. Operation and maintenance data.
- F. Warranties.

1.4 QUALITY ASSURANCE:
- A. ARI Certification: Signed by manufacturer certifying compliance with requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
- B. ASHRAE Certification: Signed by manufacturer certifying compliance with ASHRAE 15 for safety code for mechanical refrigeration. Comply with ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
- C. ASME Compliance: Fabricate and label water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. Comply with NFPA 70.
- E. Comply with UL 1995.
- F. Equipment efficiency shall meet Washington State Non-residential Energy Code and ASHRAE Standard 90.1.

1.5 DELIVERY, STORAGE, AND HANDLING:
- A. Deliver, store, protect and handle products to site under provisions of Section 15000.
- B. Unit shall be stored and handled per unit manufacturer’s recommendations.
- C. Unit controls shall be capable of withstanding 150 F (66 C) storage temperature in the control compartment for an indefinite period of time.

1.6 WARRANTY:
- A. Provide a 5-year warranty on all parts and labor.
- B. Warranty: Include coverage of chiller package as manufactured and delivered to site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

B. Rotary Screw Water Chillers:

7. Trane.
8. York.

2.2 GENERAL:

A. Provide and install as shown on the plans, factory assembled, factory charged with HFC-134a refrigerant and factory run-tested, air-cooled, rotary screw compressor chillers in the quantity specified. Each chiller shall consist of multiple semi-hermetic rotary screw compressors, shell-and-tube evaporator, air-cooled condenser section, control system and all components necessary for protected and controlled unit operation. Chillers using zeotropic refrigerants such as HFC-407C shall have a five-year refrigerant warranty.

B. Performance: Refer to the schedule of performance on the drawings. The chiller shall be capable of stable operation down to 15 percent of full load without hot gas bypass. Performance shall be in accordance with ARI Standard 550/590-98. The unit shall be capable of operating at ambient temperatures down to 35°F, and high ambient temperatures up to 125°F

2.3 CHILLER COMPONENTS:

A. Compressors: The compressors shall be field serviceable, semi-hermetic, single-rotor screw type with one central helical rotor meshing with two opposing gaterotors and have an integral oil separator. Compressor capacity shall be controlled with an infinite position slide valve, accurately matching compressor capacity to load. An economizer shall be provided, either compressor-integrated or external, for added efficiency. Compressors shall be sound and vibration isolated from the frame by neoprene compression mounts. If a twin-screw design is used, the manufacturer shall provide an extended 5-year parts and labor warranty covering all moving parts.

B. Electric motors: Motors shall be high torque, two pole, semi-hermetic, squirrel cage induction type with inherent thermal protection on all three phases and cooled by suction gas.

C. Solid-State Motor Starters (for each compressor): Starter shall be designed using the current generation of reliable solid-state technology. Each starter shall provide controlled motor acceleration and deceleration, and shall extend protections covering the following conditions: phase rotation, electronic thermal overload, over/under current, stalled motor, single phase, high load current and current unbalance. Across-the-line or wye-delta starters are not the same and not acceptable. Acceptable solid-state starter manufacturers are General Electric, Cutler-Hammer, Benshaw or Reliance. The solid-state starters shall be capable of self-diagnostics, metering, and have an LED display to include the following operating and fault messages:

9. Operating Messages:
    a. Line voltage not present
    b. Voltage present, starter ready
    c. Motor accelerating
    d. Motor at full speed
    e. Motor at full speed, ramp time expired
    f. Stop command received, motor decelerating
    g. Thermal overload has reached 90% to 99%
    h. Thermal overload at 100%, motor stopped
    i. Thermal overload reduced to 60%, motor can restart
    j. Passcode enabled
    k. Passcode disabled
    l. Thermal overload content in percentage
10. Fault Messages:
    a. System power not three phase

b. Phase sequence incorrect
c. Line frequency less than 25 Hz
d. Line frequency more than 72 Hz
e. Excessive current unbalance
f. Operating parameters lost
g. No current after "Run" command
h. Undercurrent trip occurred
i. Overcurrent trip occurred
j. Control power too low
k. Motor stalled during acceleration
l. External fault

D. Evaporator: The evaporator shall be direct expansion shell-and-tube type with individual refrigerant circuits. The evaporator shall be made up of a carbon steel shell, polypropylene water baffles and high efficiency internally finned copper tubes rolled into steel tube sheets. Flows shall be single pass on both the refrigerant and water sides for high efficiency counter-flow heat transfer and low pressure drops. Refrigerant heads shall be removable for serviceability. Water connections shall be left-handed as shown on the drawings. The evaporator shall be insulated with minimum 3/4 inch (19mm) closed cell polyurethane insulation and be electrically heated to help provide ambient freeze protection to -20°F (-29°C). The evaporator shall be designed, inspected and stamped in accordance with ASME Section VIII requirements. The evaporator shall be operationally freeze-protected by a chilled water-flow detection device wired to designated terminals in the control panel. Acceptable flow sensing devices include electronic thermal-dispersion sensors and field installed paddle-type flow switches. A suction shut-off valve shall be provided to isolate the compressor for serviceability.

E. Condenser: The condenser coils shall have seamless copper tubing, mechanically bonded into aluminum plate-type fins. The fins shall have full drawn collars, completely covering the tubes for protection against atmospheric corrosion and to provide greater heat transfer. A sub-cooling coil shall be an integral part of the main condenser coil. All external coil surfaces shall be protected by PVC coated welded-wire-mesh grills. Condenser fans shall be propeller type, arranged for vertical air discharge and individually driven by direct drive motors. Each fan shall be housed in its own compartment to eliminate condenser-air cross flow during fan cycling and shall be equipped with a heavy-gauge close-meshed PVC coated fan guard. Fan motors shall be weather protected, three-phase, direct-drive, 1140 rpm, totally enclosed air-over motors with class F insulation or better. Open drip-proof (ODP) motors are not acceptable. Vertical service clearance under the condenser coil shall be minimum six feet for access to the compressor and major components. Horizontal condenser coils are not acceptable. The condenser shall permit pump-down and storage of the full refrigerant charge for compressor serviceability.

F. Refrigerant Circuit: The unit shall have two or more refrigerant circuits, completely independent of each other. Each circuit shall be equipped with one compressor, one microprocessor controller, a factory-mounted control circuit transformer, oil separator, electronic expansion valve, compressor suction shutoff valve, combination discharge check and shutoff valve, liquid line shutoff valves, replaceable core filter-dryers, liquid line solenoid valve and sight-glass with moisture indicator. Each circuit shall be capable of operating independently, not being disabled in the event of fault(s) on the other circuit(s).

G. Unit casing and all structural members and rails shall be painted to meet ASTM B117, 500-hour salt-spray test. The control enclosure and unit panels shall be cleaned, phosphatized and then corrosion resistant urethane painted before assembly.

H. Advanced microprocessor-based control system: The control system architecture shall provide distributed-control where each compressor circuit has its own microprocessor controller so in the event that one controller becomes inoperative, the other circuits will continue to operate uninterrupted.

11. Control Panel: A NEMA Type 3R weatherproof control panel shall contain the unit control system, control interlock terminals and field-power connection points. Hinged control panel access doors shall be lockable. Barrier panels shall be provided to protect against accidental contact with line voltage when accessing the control system.

a. Door Accessories:
    1) Provide Automatic Shut off (Kill) switches on fan access doors.

12. Factory-supplied power components shall include: single-point power connection with circuit breaker, factory-mounted non-fused type service disconnect switch, individual contactors and circuit breakers for fan motors, circuit breakers and factory mounted transformers for each control-circuit, terminals for power supply to the evaporator heater circuit, and 115-volt 15 amp. ground-fault protected service-convenience outlet. Fan motors shall have inherent overload protection and compressor motors shall have three-phase motor overload protection.
13. Control system starting components shall include solid-state start timer.
14. The control logic shall be designed to maximize operating efficiency and equipment life with protections for operation under unusual conditions and to provide a history of operating conditions. The system shall intelligently stage the unit to sustain leaving water temperature precision and stability while minimizing compressor cycling.
15. Equipment protection functions controlled by the microprocessor shall include high discharge pressure, loss of refrigerant, loss of water flow, freeze protection, and low refrigerant pressure.
16. User controls shall include auto/stop switch, chilled water set-point adjustment, anti-recycle timer, and digital display with water temperature and set-point, operating temperatures and pressures, and diagnostic messages.
17. The following features and functions shall be included:
    a. Durable liquid crystal display (LCD) screen type, having minimum four 20-character lines with 6 key input pads conveniently mounted on the unit controller. Default language and units of measure shall be English and I-P respectively. Messages shall be in plain English. Coded messages, LED indicators and LED displays are not acceptable
    b. Separate control section and password protection for critical parameters.
    c. Remote reset of chilled water temperature using a 4-20mA signal.
    d. Soft-load operation, protecting the compressor by preventing full-load operation during the initial chilled fluid pull-down period.
    e. BAS communication flexibility through protocol selectability. Optional modular plug-ins that enable the unit controller to communicate using standardized protocols such as BACnet®, MODBUS® and LONWORKS®.
    f. Non-volatile program memory allowing auto-restart after a power failure without requiring a UPS (un-interruptible power supply).
    g. Recording of safety shutdowns, including date-and-time stamp with system temperatures and pressures. A minimum of six previous occurrences shall be maintained in a revolving memory.
    h. Start-to-start and stop-to-start cycle timers, further optimizing motor protection.
    i. Lead-lag compressor staging for part-load operation by manual selection or automatically by circuit run hours.
    j. Discharge pressure control through intelligent cycling of condenser fans to maximize efficiency.
    k. Pro-active compressor unloading when selected operating parameters exceed design settings, such as high discharge pressure or low evaporator pressure.
    l. Diagnostic monitoring of unit operation, providing a pre-alarm signal in advance of a potential shutdown, allowing time for corrective action.
18. Factory mounted DDC controller(s) shall support operation via BACnet® Open Standard Protocol using either BACnet MS/TP, BACnet IP or BACnet Ethernet data link / physical layer as specified by the Building Automation System (BAS) supplier. The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list. All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2001). A BACnet Protocol

Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

2.4 OPTIONS AND ACCESSORIES:

A. The following options are to be included:

19. Vibration Control Mountings: High deflection, minimum 1 inch, spring vibration isolators for field installation.
20. Chilled water flow switch to be factory mounted in the chilled water outlet nozzle and factory wired to terminals in the control panel.
21. Single point power connection.

PART 3 - EXECUTION

3.1 WATER CHILLER INSTALLATION:

A. Install in strict accordance with manufacturer’s requirements, shop drawings, and contract documents.
B. Adjust and level chiller in alignment on supports.
C. Coordinate electrical installation with electrical contractor.
D. Coordinate controls with control contractor.
E. Vibration Isolation: Rubber pads with a minimum deflection of 0.25 inch. Vibration isolation devices and installation requirements are specified in Division 23 Section "Mechanical Vibration Controls and Mechanical Seismic Controls."
F. Maintain manufacturer's recommended clearances for service and maintenance.
G. Install separate devices furnished by manufacturer.
H. Provide all requirements to give a fully operational and properly functional chiller.

3.2 CONNECTIONS:

A. Chilled-water piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to chiller to allow service and maintenance.
C. Evaporator Connections: Connect inlet to evaporator with controller-bulb well, shutoff valve, thermometer, strainer, pressure gage, and union or flange. Connect outlet to evaporator with shutoff valve, flow switch, balancing valve, thermometer, pressure gage, and union or flange.
D. Ground chillers according to Division 26 Section "Grounding and Bonding."
E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 STARTUP SERVICE:

A. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
B. Provide factory trained personnel for starting of the chiller(s), and instruct the owner on proper chiller operation and maintenance. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

22. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
23. Verify that pumps are installed and functional.
24. Verify that thermometers and gages are installed.
25. Operate water chiller for run-in period according to manufacturer's written instructions.
26. Check bearing lubrication and oil levels.
27. Verify proper motor rotation.
28. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
29. Verify and record performance of chilled-water flow and low-temperature interlocks.
30. Verify and record performance of water chiller protection devices.
31. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
32. Prepare a written startup report that records results of tests and inspections.

3.4 COMMISSIONING:

A. Selected equipment and systems are to be commissioned per Section 01800 - General Commissioning Requirements and Section 23 08 00 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 64 26

SECTION 23 72 00 HEAT RECOVERY VENTILATOR UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged heat recovery ventilators units for indoor installations (DOAS units).

1.2 REFEERENCES

A. AMCA Standard 99: Standards Handbook
B. AMCA /ANSI Standard 204: Balance Quality and Vibration Levels for Fans
C. AMCA Standard 210: Laboratory Methods of Testing Fans for Ratings
D. AMCA Standard 300: Reverberant Room Method for Sound Testing of Fans
E. AMCA Standard 500:Test Methods for Louvers, Dampers and Shutters
F. ARI Standard 410: Forced-Circulation Air-Cooling and Air-Heating Coil
G. ASHRAE Standard 52: Gravimetric and Dust Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
H. ASHRAE/ANSI Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems
I. ASME Section VIII: Unified Pressure Vessel Code
J. UL Standard 1995: Heating and Cooling Equipment
K. ASTM A-525: Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

1.3 SUBMITTALS

A. Product Data: For each type of modular indoor air-handling unit indicated. Include the following:
    1. Dimensioned plan and elevation view drawings, including all required clearances, access locations and all required field connections. Unit weight.
    2. Literature and/or performance data on unit construction and devices.
    3. Certified fan-performance curves with system operating conditions indicated.
    4. Certified fan-sound power ratings, unit inlets, outlets and radiated sound levels.
    5. Certified coil-performance ratings with system operating conditions indicated.
    6. Motor ratings, electrical characteristics, and motor and fan accessories.
    7. Variable Frequency Drive (VFD) product literature and features.
    8. Material gages and finishes.
    9. Filters with performance characteristics.
    10. Dampers, including housings, linkages, and operators.
    11. Defrost control system, sensors and wiring diagram.
    12. O&M data, including lubrication, filter replacement, spare parts and wiring diagrams.

1.4 OPERATION AND MAINTENANCE DATA

A. Include data on design, inspection and procedures related to preventative maintenance. Operation and Maintenance manuals shall be submitted at the time of unit shipment.

1.5 QUALITY ASSURANCE

A. Manufacturer shall be a company specializing in the design and manufacture of commercial / industrial custom HVAC equipment. Manufacturer shall have been in production of custom HVAC equipment for a minimum of 5 years.
B. Each unit shall bear an ETL, CSA or UL label under UL Standard 1995 indicating the complete unit is listed as an assembly. ETL, CSA or UL listing of individual components, or control panels only, is not acceptable.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. NFPA Compliance: Modular indoor air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
E. ARI Certification: Modular indoor air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
F. Coil Performance shall be certified in accordance with ARI Standard 410.
G. Airflow data shall comply with AMCA 210 method of testing.
H. Air handling unit sound power levels are not to exceed those levels listed on the drawings. Furnish sound power level data as indicated.
I. Units with factory wiring shall be factory approved and labeled. All units shall be run tested prior to shipment.
J. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 211, 300, 301, 500 and ARI 410. All electrical components and assemblies shall comply with NEMA standards. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, “Standard for the Installation of Air Conditioning and Ventilating Systems.” Units shall comply with NFPA 70, “National Electrical Code,” as applicable for installation and electrical connections of ancillary electrical components of air handling units. Units shall be UL or ETL listed.

1.6 DELIVERY, STORAGE AND PROTECTION
A. Ship units with a minimum of a 10 mil poly shrink-wrap covering, Inspect for transportation damage and store in clean dry place and protect from weather, moisture intrusion and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
B. Unit shall be stored and handled per unit manufacturer's recommendations, which shall generally include being heated and ventilated during storage in order to prevent moisture inrustion. Units subject to moisture penetration during shipping and storage shall be inspected for moisture damage and/or mold growth at the contractor’s expense and if damage is found, units shall be repaired or replaced at no cost to the owner.

1.7 START-UP REQUIREMENTS
A. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, condensate properly trapped, piping connections verified and leak tested, belts aligned and tensioned, all shipping braces have been removed, and fan has been test run under observation

1.8 WARRANTY
A. The complete unit shall be covered by a parts warranty issued by the manufacturer covering the first year of operation. This warranty period shall start upon receipt of start-up forms or eighteen months after the date of shipment.
B. The installing contractor shall provide labor warranty during the unit’s first year of operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Haakon
2. Venmar
3. Innovent
4. Temtrol
5. Huntair
6. York Custom

2.2 INDOOR HEAT RECOVERY VENTILATOR UNIT
A. General

1. Furnish and install where shown on the plans, Packaged indoor heat recovery ventilator consisting of a flat plate heat exchanger, ventilation air fan, exhaust air fan, filters, necessary dampers/actuators, and internal defrost and controls, with construction features as specified below. The units shall be provided and installed in strict accordance with the specifications. All units shall be complete with all components and accessories as specified. Any exceptions must be clearly defined. The contractor shall be responsible for any additional expenses that may occur due to any exception made.
2. Units shall have overall dimensions as indicated on drawings and fit into the space available with adequate clearance for service. Units shall be shipped in sections to facilitate installation within existing structure. Multiple sectioned units shall be shipped as a single factory assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor.

B. Factory Testing:
1. Factory Leak Testing: The unit manufacturer shall perform a factory leak test on units at 8” of differential static pressure across the cabinet exterior walls. Cabinet leakage is not to exceed 1% of specified airflow on the operating side of the unit.
2. Factory Panel Deflection Testing: The unit manufacturer shall perform a factory deflection test on units at 8” of differential static pressure across the cabinet exterior walls. Cabinet deflection shall not exceed L/240 of panel length.

C. Unit Cabinet:
1. Unit base frame shall be constructed from a 6" structural steel C-channel steel base rail with internal structural cross members properly sized to allow rigging and handling of the unit. Base rails shall be fitted with lifting lugs at the corner of the unit or sections (if demounted).
2. Floor shall be double wall construction with minimum of 14 gauge G-90 galvanized steel smooth floor and 22 gauge galvanized steel bottom panel, and be insulated with minimum 3" fiberglass insulation. Maximum base deflection shall not exceed 0.25 inches on 240 inches of unsupported length.
3. Unit construction shall be made of heavy gauge galvanized steel structural frame complete with double wall insulated panels and joints sealed to prevent air leakage. Panels shall be double wall construction using 2" thick, 3.0#/cf fiberglass insulation, 16 gauge galvanized G90U brite steel exterior panels and 22 gauge perforated galvanized steel inner liner. Wall panel construction shall provide stiffeness to limit deflection to no greater than 1/200 at 1.5 times the working pressure.
4. Alternative unit cabinet construction that utilizes double wall panels with injected polyurethane foam insulation will be considered for “or equal” consideration if thermal and deflection data is equivalent to specified construction and information is provided prior to bidding.

D. Access:
1. Full size double wall, insulated access doors to allow for periodic maintenance and inspections must be provided for all serviceable components and where shown on unit details on the plans. Doors shall be complete with heavy-duty stainless-steel hinges and compression type handles.
2. Access doors serving compartments open to fans (inlet or outlet) shall contain safety interlocks which will completely shut down the fan upon opening the door.
3. Access doors shall open outwards secured with pressure relief safety latches.
4. Access doors for fan sections and sections with motorized dampers, shall be provided with viewports/windows with hermetically sealed double-glazed laminated safety glass.
5. Access doors, or spacer sections, shall be provided with instrument ports for pressure testing unit components. Instrument ports shall be provided with threaded caps.

E. Air-to-Air Crossflow Flat Plate Heat Exchanger:
1. Aluminum flat plate heat exchanger designed to meet NFPA90A requirements for smoke development and flame spread.
2. Ratings certified by the ARI Air-to-Air Energy Recovery Ventilation Equipment Certification Program, in accordance with ARI Standard 1060.

3. Corrugated aluminum air-to-air crossflow heat exchanger. Plates shall be fabricated with a corrugated pattern to increase turbulence and maximize heat transfer effectiveness. Flat plate laminar flow designs are not acceptable.
4. Plate corners shall be sealed with a silicone sealant to prevent air leakage.
5. Connecting plate edges shall be folded and sealed with an adhesive to minimize leakage.
6. Exchanger assembly shall consist of corrugated plate exchanger core, extruded aluminum corner profiles and endplate framing. Complete assembly shall form a rigid, stable unit.
7. Exchanger shall withstand 7" w.c. maximum pressure differential without permanent deformation.
8. Exchanger performance and efficiency shall be as scheduled on the drawings.

F. Non-Scrolled Plenum Type Fans:
1. Fan ratings are based on tests made in accordance with AMCA Standard 210.
2. Fans assemblies shall be direct-drive, airfoil centrifugal plenum (plug) type, designed without a scroll type housing. Fans shall incorporate a wheel, heavy gauge reinforced steel inlet plate with removable spun inlet cone, structural steel frame, and shaft and bearings in AMCA Arrangement 4 configuration as an entire assembly.
3. All fan wheels shall have tapered spun wheel cones or shrouds providing stable flow and high rigidity. The wheels shall be non-overloading type.
4. The blades shall be continuously-welded, die-formed Airfoil type, designed for maximum efficiency and quiet operation. Partial welding will not be acceptable on airfoil blades.
5. Impellers shall be statically and dynamically balanced and the complete fan assembly shall be test balanced at the operating speed prior to shipment.
6. Shafts to be sized for first critical speed of at least 1.43 times the maximum speed for the class. Bearings are to be heavy duty, grease lubricated, anti-friction ball or roller, self-aligning, pillow block type and selected for an L10 200,000-hour life at the maximum class RPM.
7. Provide OSHA approved fully enclosed metal belt guard sides of galvanized steel and an expanded metal face. Belt guard shall be sized to allow either sheave to be increased by two sizes.
8. Plenum fan assembly must have an enclosed safety screen as per OSHA Standards.
9. Fans shall have inlet OSHA approved inlet screens.
10. Fans and motors shall be mounted on an integral vibration isolator base with 2" deflection springs vibration isolators.
11. Fan blades shall be statically and dynamically balanced and tested prior to shipment.
12. Bearings shall be provided with extended lube lines with connection points outside of the protective fan cage.

G. Airflow Measurement and Display:
1. Provide air flow measurement device on each fan with method to digitally display, in real time, fan air flow volume (in cfm).
2. Each airflow probe shall contain multiple, averaged velocity pressure taps located symmetrically around the throat of the fan inlet and a single static pressure tap located on the fan housing. The entire monitoring probe must be located outside the inlet throat so as to not obstruct airflow, equal to the FreeFlo Sensing Ring as manufactured by Haakon Industries.
3. Local airflow display shall be capable of showing airflow for two (2) independent fans, simultaneously. Display mounted recessed in unit cabinet.
4. Airflow measurement display module shall provide a 0-10VDC output signal to the EMCS system, for each fan being monitored.

H. Motors:
1. Fan motors shall be heavy duty, 1800 rpm, high efficiency, open drip proof (ODP), NEMA Design B with Class F insulation and 1.15 service factor. Motors shall be suitable for variable frequency drive duty and shall be provided with motor shaft grounding devices, and shall meet NEMA MG1 Part 31.
2. Motors shall meet EPAC regulations for efficiency and shall have inverter spike resistance wire for protection.
3. Motors shall be designed for direct drive applications and mounting.

I. Water Coils:
   1. All water coils shall be provided to meet the scheduled performance. All coil performance shall be certified in accordance with ARI Standard 410. All water coils shall be tested at 450 psig air pressure.
   2. All water coils shall have minimum 1/2-in. OD copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.020 inches.
   3. Aluminum plate fin type with belled collars, minimum 0.0075” fins.
   4. Aluminum-finned coils shall be supplied with die-formed casing and tube sheets of mill galvanized steel. Clearly label supply and return connection points on outside of unit casing, such that the direction of coil water flow is counter to the direction of the unit airflow.
   5. Headers shall be constructed of steel with steel MPT connections. Headers shall have drain and vent connections accessible from the exterior of the unit.
   6. Construct coil casings of minimum 16-gauge steel with formed end supports and top and bottom channels. Coils in colling service shall have stainless steel casings and coils in heating-only service shall have galvanized steel casings.
   7. Removable coil access panels shall be provided for removal of coils through the casing wall. Coils shall be individually removable away from the access side. Coils must be individually racked, removable through the side access panels.
   8. Drain pans shall be continuously welded. Coil section must have intermediate drain pans and shall be interconnected with 1 in stainless steel drain lines. Drain pans shall be IAQ sloped and fully drainable. Where unit curb height and/or combination of unit curb and housekeeping pad (where applicable) are not tall enough for proper P-trap seal dimensions, provide drain pan that is fully within unit housing and do not use unit base rail area for drain pan depth.
   9. Configuration: Coils shall be drainable, with non-trapping circuits. Coils will be suitable for a design working pressure of 300 psig at 200 F.

J. Drains:
   1. Provide drain pans and/or floor drains with 1-inch connections at the accessible side of the unit for the following sections:
      a. Cooling coil drain pan.
      b. Air-to-air heat recovery core defrost section.
      c. Outside air intake section.

K. Filtration:
   1. Filters shall be installed in prefabricated channel racks or holding frames with gasketed closures to prevent air bypass.
   2. Filters shall be standardized in size as either 12”x24 or 24”x24” modules sizes. Refer to Section 23 41 00.
   3. Supply airstream:
      a. Prefilters: 2" thick, disposable type MERV 7 air filters with 25 - 30% efficiency.
      b. Final filters: 12” thick, MERV 13 air filters with 80 to 85% efficiency.
   4. Exhaust airstream:
      a. Prefilters: 2" thick, disposable type MERV 7 air filters with 25 - 30% efficiency.

L. Openings:
   1. Exhaust air openings directly in the side of the unit casing, that are to be open to the room plenum air flow, shall be furnished with 1/2”x 1/2” wire mesh screens.

M. Filter Gauges:
   1. Provide Dwyer 2000 magnehelic gauges, one gauge per filter bank, recessed into cabinet casing.

N. Lights:
   1. Marine lights with protective metal cage and glass seals, shall be installed inside each accessible section. A rotary timer light switch, 0-60 minutes, shall be provided on the outside of the unit. Electrical power shall be 120V/1/60. Lights shall be equipped with compact fluorescent bulbs. Wiring shall be in rigid EMT conduit.

O. Finish:

1. Unit shall be finish finished painted with two components, etch bond primer and finish painted with alkyd enamel. All uncoated steel shall be painted with grey enamel. All metal surfaces shall be prepainted with vinyl wash primer to ensure paint bonds to metal.

P. Aluminum Airfoil Dampers:
1. Airfoil dampers shall be low leakage design with blade edge seals and frame jam seals.
2. Provide shut-off dampers at unit outside air intake connection and at unit exhaust discharge connection.
3. Provide modulating control dampers at air-to-air heat exchanger for face and bypass defrost and economizer control. Provide modulating control damper at auxiliary economizer exhaust air intake to exhaust fan section.
4. Aluminum airfoil frames and blades shall be a minimum of 12-gauge extruded aluminum. Blades shall be of a single unit airfoil design, 6 inched wide.
5. Frames shall be extruded aluminum channels with grooved insert for vinyl seals.
6. Blade linkage hardware shall be installed in frame to be out of the air-stream. All hardware shall be non-corrosive, reinforced material of cadmium plated steel. Bearings shall be nylon type.

Q. Damper Operators:
1. Electric motorized damper operators shall be provided by the air handling unit manufacture for the face and bypass defrost controls on the air-to-air heat exchanger. Provide with all required linkages and mounting hardware.
2. Coordinate with EMCS contractor for interface between defrost control and economizer control.

R. Defrost Controls:
1. Face and Bypass Defrost Cycle:
2. Unit shall be equipped with face and bypass defrost dampers and operators to prevent frost from forming on the flat plate heat exchanger and to maintain ventilation at all times.
3. Defrost control system (sensors, wiring, controller, etc.) shall be provided by AHU manufacturer and function independent of the building control system. Coordinate with EMCS contractor to provide damper interface for economizer (heat exchanger bypass) sequence of operation.

S. Electrical Requirements:
1. All electrical controls shall be ETL, CSA or UL listed and the entire unit shall be factory wired in accordance with the National Electrical Code Standard
2. Unit shall be equipped with all necessary high voltage components as follows:
   a. Motor starters on all high voltage motors for constant speed applications.
   b. Thermal protection on all high voltage motors.
   c. Fuses and fuse holders.
   d. All necessary control transformers
3. Unit shall have single point power connection only.
4. All controls shall be factory mounted and wired, requiring only field installation of remote sensing devices and wiring to unit mounted terminal strips.

T. Variable Frequency Drives (VFD):
1. Each fan shall be provided with a variable frequency drive (VFD) that is prewired and mounted on the accessible side of the air handling unit.
2. VFDs shall be provided in accordance with the requirements of Section 23 09 26 Variable Frequency Drives, and factory installed under this section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install indoor heat recovery ventilator units with the following vibration-control devices. Vibration-control devices are specified in Division 23 Section "Mechanical Vibration Controls."
1. Units with Internally Isolated Fans: Support on concrete bases using neoprene pads. Secure units to anchor bolts installed in concrete bases.

B. Arrange installation of units to provide access space around the units for service and maintenance.
C. Install units on a flat surface level within 1/8 inch and of sufficient strength to support the unit.
D. Install in strict accordance with manufacturer's requirements, shop drawings, and Contract Documents.
E. Contractor shall include in their bid all labor and materials necessary to install air handling units (i.e. work resulting from shipping splits, etc).
F. Coordinate with air handling unit manufacturer all field work required with each air handling unit. This shall include all work required by other trades (i.e. electrical, controls, pipe fitters, sheet metal, structural, etc.) necessary to complete the installation of the air handling units.
G. Adjust in alignment on concrete foundations, sole plates or other supporting structure. Level, grout, and bolt in place.
H. Coordinate electrical installation with electrical contractor.
I. Coordinate controls with control contractor.
J. Provide all appurtenances required to ensure a fully operational and functional system.
K. Fan mounted Air Measuring Stations to be factory provided under this section of specification. Coordinate control interface with Section 23 09 23.
L. Damper actuators noted on Temperature Control Diagrams shall be factory mounted on unit in accessible locations. See Section 23 09 23 for actuator specification. Control wiring shall be performed in field by division 23 09 23.

3.2 CONNECTIONS

A. On units without internally isolated fans, install flexible connections between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum 1inch flex between ductwork and fan while running
B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
C. Install piping adjacent to unit to allow service access and maintenance.
D. Connect condensate drain pans and section drains, using Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan with dimension in accordance with manufacturer's recommendations.
E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection.
F. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.
G. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
H. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.3 START-UP

A. Factory Start-Up Services: Start-up is to be supervised by the unit manufacturer or a manufacturer certified service organization. Physical connections and start-up are provided by the installing contractor. Start-up services shall be provided for as long a period of time as is necessary to ensure proper operation of the unit. The start-up engineer shall conduct such operating tests as required to ensure that the unit is operating in accordance with design. Complete testing of all safety and emergency control devices shall be made. The start-up engineer shall submit a written report to the owner and manufacturer containing all test data recorded as required above and a letter certifying that the unit is operating properly.
B. Operation and Maintenance Manuals: Manual shall be provided complete with descriptive literature, model, and serial number of all equipment, performance data, manufacturer's instructions for operating and maintenance, lubrication recommendation and schedule, and winter shutdown procedure.

3.4 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 72 00

SECTION 23 73 13 - MODULAR AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes modular variable volume, air-handling units for outdoor installations.

1.2 REFERENCES

A. AMCA Standard 99: Standards Handbook
B. AMCA /ANSI Standard 204: Balance Quality and Vibration Levels for Fans
C. AMCA Standard 210: Laboratory Methods of Testing Fans for Ratings
D. AMCA Standard 300: Reverberant Room Method for Sound Testing of Fans
E. AMCA Standard 500: Test Methods for Louvers, Dampers and Shutters
F. ARI Standard 410: Forced-Circulation Air-Cooling and Air-Heating Coil
G. ASHRAE Standard 52: Gravimetric and Dust Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
H. ASHRAE/ANSI Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems
I. ASME Section VIII: Unified Pressure Vessel Code
J. UL Standard 1995: Heating and Cooling Equipment
K. ASTM A-525: Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

1.3 SUBMITTALS

A. Product Data: For each type of modular indoor air-handling unit indicated. Include the following:
   1. Dimensioned plan and elevation view drawings, including all required clearances, access locations and all required field connections. Unit weight.
   2. Literature and/or performance data on unit construction and devices.
   3. Certified fan-performance curves with system operating conditions indicated.
   4. Certified fan-sound power ratings, unit inlets, outlets and radiated sound levels.
   5. Certified coil-performance ratings with system operating conditions indicated.
   6. Motor ratings, electrical characteristics, and motor and fan accessories.
   7. Variable Frequency Drive (VFD) product literature and features.
   8. Material gages and finishes.
   9. Filters with performance characteristics.
   10. Dampers, including housings, linkages, and operators.
   11. Defrost control system, sensors and wiring diagram.
   12. O&M data, including lubrication, filter replacement, spare parts and wiring diagrams.

1.4 OPERATION AND MAINTENANCE DATA

A. Include data on design, inspection and procedures related to preventative maintenance. Operation and Maintenance manuals shall be submitted at the time of unit shipment.

1.5 QUALITY ASSURANCE

A. Manufacturer shall be a company specializing in the design and manufacture of commercial / industrial custom HVAC equipment. Manufacturer shall have been in production of custom HVAC equipment for a minimum of 5 years.
B. Each unit shall bear an ETL, CSA or UL label under UL Standard 1995 indicating the complete unit is listed as an assembly. ETL, CSA or UL listing of individual components, or control panels only, is not acceptable.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. NFPA Compliance: Modular indoor air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
E. ARI Certification: Modular indoor air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
F. Coil Performance shall be certified in accordance with ARI Standard 410.
G. Airflow data shall comply with AMCA 210 method of testing.
H. Air handling unit sound power levels are not to exceed those levels listed on the drawings. Furnish sound power level data as indicated.
I. Units with factory wiring shall be factory approved and labeled. All units shall be run tested prior to shipment.
J. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 211, 300, 301, 500 and ARI 410. All electrical components and assemblies shall comply with NEMA standards. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, “Standard for the Installation of Air Conditioning and Ventilating Systems.” Units shall comply with NFPA 70, “National Electrical Code,” as applicable for installation and electrical connections of ancillary electrical components of air handling units. Units shall be UL or ETL listed.

1.6 DELIVERY, STORAGE AND PROTECTION
A. Ship units with a minimum of a 10 mil poly shrink-wrap covering, Inspect for transportation damage and store in clean dry place and protect from weather, moisture intrusion and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
B. Unit shall be stored and handled per unit manufacturer's recommendations, which shall generally include being heated and ventilated during storage in order to prevent moisture inrustion. Units subject to moisture penetration during shipping and storage shall be inspected for moisture damage and/or mold growth at the contrator’s expense and if damage is found, units shall be repaired or replaced at no cost to the owner.

1.7 START-UP REQUIREMENTS
A. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, condensate properly trapped, piping connections verified and leak tested, belts aligned and tensioned, all shipping braces have been removed, and fan has been test run under observation

1.8 WARRANTY
A. The complete unit shall be covered by a parts warranty issued by the manufacturer covering the first year of operation. This warranty period shall start upon receipt of start-up forms or eighteen months after the date of shipment.
B. The installing contractor shall provide labor warranty during the unit’s first year of operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Trane – Performance Climate Changer Series.
2. York/JCI – Solution Series.
3. Approved Equal

2.2 MODULAR INDOOR AIR-HANDLING UNIT
A. General
1. Furnish and install where shown on the plans, modular frame air handling units with construction features as specified below. The units shall be provided and installed in strict accordance with the specifications. All units shall be complete with all components and

accessories as specified. Any exceptions must be clearly defined. The contractor shall be responsible for any additional expenses that may occur due to any exception made.

2. Units shall have overall dimensions as indicated on drawings and fit into the space available with adequate clearance for service. Units shall be shipped in sections to facilitate installation within existing structure. Multiple sectioned units shall be shipped as a single factory assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor.

B. Factory Testing:

3. Factory Leak Testing: The unit manufacturer shall perform a factory leak test on units at 8" of differential static pressure across the cabinet exterior walls. Cabinet leakage is not to exceed 1% of specified airflow on the operating side of the unit.
4. Factory Panel Deflection Testing: The unit manufacturer shall perform a factory deflection test on units at 8" of differential static pressure across the cabinet exterior walls. Cabinet deflection shall not exceed L/240 of panel length.

C. Unit Construction:

5. Unit Base / Floor:
   a. Provide a full perimeter welded base frame manufactured with structural steel tubing and C-Channel cross support members on close centers. Base rails shall be fitted with lifting lugs at the corner of the unit or sections (if demounted). The base shall include an insulated "double bottom" floor equivalent to the wall construction, with and heavy gauge G-90 galvanized inner walk-on surface. All floor seams shall be caulked and sealed for an airtight unit. Where access is provided to the unit interior, floor openings shall be covered with walk on steel safety grating. Single wall floors with glued and pined insulation are not acceptable. Base frame shall be attached to the unit at the factory.
6. Exterior Panel
   a. All exterior panels including cooling coil sections shall be minimum 2 inch thick G90 galvanized steel. All panel seams shall be caulked and sealed for an airtight unit. Leakage rates shall be less than 1% at design static pressure. The exterior panel finish shall have factory baked enamel finish, manufacturer's standard color.
7. Double Wall Construction
8. Each unit shall have double wall, thermally broken construction with solid galvanized steel liner on the suction side of the fans and perforated liner at the discharge of the fans when indicated on the equipment schedules on the plans.
9. Insulation
10. Entire unit to be insulated with a full 2" thick polyurethane injected foam insulation of not less than R-13.
    a. Access Doors
    b. The unit shall be equipped with 2-inch thick solid double wall insulated, hinged access doors as shown on the plans. The doorframe shall be extruded aluminum with a built in thermal break barrier and full perimeter gasket. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors.
    c. Access doors serving fan compartments (inlet & outlet) shall contain safety interlock which will completely shut down the fan upon opening the door.
11. Fans
    a. Plug Fan (PF) SWSI fans: Fan shall be single width single inlet airfoil blade plenum fan as indicated on the schedule. Fan blades shall be hollow airfoil in shape, welded to the center and wheel side plates. Fan bearings shall be heavy duty, pillow block, self-aligning ball type (roller bearings for all 33" diameter and greater fans). Bearings shall be selected for a minimum L-50 life at 400,000 hours, at maximum horsepower and operating speed for the classification. Fan shaft shall be turned, ground and polished solid steel rated at maximum RPM below critical speed. Fan wheel and sheaves shall be keyed to the shaft. Fan shall be statically

and dynamically prior to shipment with motor, sheaves, and belts in place. Fan shall be rated in accordance with AMCA 211 for performance and AMCA 300/301 for sound. Provide with extended grease lubrication lines with fittings on fan base near access door.

b. Plenum fan assembly must have an enclosed safety screen as per OSHA Standards.
c. Fans shall have inlet OSHA approved inlet screens.
d. Fan and motor shall be mounted internally on a steel base. Fan and motor shall be mounted on 2” deflection spring vibration isolator which is anchored to the unit base and frame.

12. Airflow measuring devices:
    a. Provide airflow monitoring device as indicated on plans. See specification 230900 for requirements.
13. Plenum Fans:
    a. Air Monitoring device shall consist of an array of nominal 3” long, differential pressure flow sensors mounted at opposing 90º positions around the inlet of the plenum fan. Flow sensors shall be manifolded together with pneumatic tubing and tubing extended to the unit exterior. Each fan and air monitoring device shall have been tested for airflow vs. differential pressure and calibrated in an AMCA Accredited Laboratory. Air monitoring device shall not obstruct the fan inlet or be directly mounted across the fan inlet, or have any effect on fan air performance or sound power levels.
14. Motors
    a. All motors shall be rated for Variable Frequency Drive operation. See section 23 09 26 for VFD drives.
    b. Motors shall be NEMA Design B; T-FRAME mounted on an adjustable heavy steel base. The motors shall be tested to IEEE standard 112 test method B and NEMA MG 12.58.2 and 12.59 table 12-10. All motors shall meet the energy policy act (EPAct) regulations. Motors shall meet the electrical characteristics as specified for voltage, rpm, and efficiencies in Section 23 05 13.
15. Variable Frequency Drives (VFD):
    a. 1. Each fan shall be provided with a variable frequency drive (VFD) that is prewired and mounted on the accessible side of the air handling unit.
    b. 2. VFDs shall be provided in accordance with the requirements of Section 23 09 26 Variable Frequency Drives, and factory installed under this section.
16. Drives
    a. VP “Variable Pitch” drives sheaves shall be furnished on motors up to 3 HP and fixed pitch on motors greater than 3 HP. Fixed pitch sheaves shall be provided on all fans in excess of 2,000 rpm. V-Belt drives shall be selected at 150% motor nameplate horsepower. Unit manufacturer to provide a sheave change after final field balance.
17. Water Coils
    a. PSIG and performance is to be certified under ARI Standard 410. Coils exceeding the range of ARI standard rating conditions shall be noted.
    b. Cooling coils shall be mounted on stainless steel support rack to permit coils to slide out individually from the unit. Provide intermediate drain pans on all stacked cooling coils. The intermediate pan shall drain to the main drain pan through a copper downspout. Water coils shall be constructed of seamless copper tubing mechanically expanded into fin collars. All fins shall be continuous within the coil casing to eliminate carryover inherent with a split fin design. Fins are die formed Plate type.
    c. Headers are to be seamless copper with die formed tube holes.
    d. Connections shall be male pipe thread (MPT) Schedule 40 Red Brass with 1/8" vent and drain provided for complete coil drainage. All coil connections shall be extended to the exterior of the unit casing by the manufacturer. Coils shall be suitable for 250 PSIG working pressure. Intermediate tube supports shall be

supplied on coils over 44" fin length with an additional support every 42" multiple thereafter.

e. Unit shall be provided with external pipe chase for coil connections.

f. Water coils shall have the following construction:

1) Standard 1/2” or 5/8” :

a) 1/2” or 5/8" o.d. x .020" wall copper tube.

b) .0075" aluminum fins

c) 16 gauge galvanized G-90 steel casing

D. Piping Vestibule

18. Unit shall be provided with a piping vestibule sized to accommodate all coil connection components (control valves, hose kits, strainers, ports, etc). Vestibule may internal or external to unit footprint. Coordinate with hydronic piping contractor prior to ordering to ensure vestibule is sized appropriately. Ceiling mounting of coil components will not be acceptable.

E. Condensate Pan

a. Drain pans shall be provided under all cooling coils sections as shown on the drawings. The drain pan shall be fabricated from 304 stainless steel. All pans are to be sloped for complete drainage with no standing water in the unit. They shall be insulated minimum 3-inch "Double Bottom" construction with welded corners. Provide stainless steel, 1-1/4” MPT drain connection extended to the exterior of the unit base rail.

F. Air-to-Air Crossflow Flat Plate Heat Exchanger:

1) Aluminum flat plate heat exchanger designed to meet NFPA90A requirements for smoke development and flame spread.

2) Ratings certified by the ARI Air-to-Air Energy Recovery Ventilation Equipment Certification Program, in accordance with ARI Standard 1060.

3) Corrugated aluminum air-to-air crossflow heat exchanger. Plates shall be fabricated with a corrugated pattern to increase turbulence and maximize heat transfer effectiveness. Flat plate laminar flow designs are not acceptable.

4) Plate corners shall be sealed with a silicone sealant to prevent air leakage.

5) Connecting plate edges shall be folded and sealed with an adhesive to minimize leakage.

6) Exchanger assembly shall consist of corrugated plate exchanger core, extruded aluminum corner profiles and endplate framing. Complete assembly shall form a rigid, stable unit.

7) Exchanger shall withstand 7” w.c. maximum pressure differential without permanent deformation.

8) Exchanger performance and efficiency shall be as scheduled on the drawings.

G. Filter Section

b. Provide filters per Section 23 41 00. Factory fabricated filter sections shall be of the same construction and finish as the unit. Face loaded pre and final filters shall have Type 8 frames as manufactured by FARR. Side service filter sections shall include hinged access doors on both sides of the unit. Internal blank-offs shall be provided by the air unit manufacturer as required to prevent air bypass around the filters.

c. Filter Gage: Each Filter bank shall be furnished with: Magnehelic filter gage Dwyer Series 2000.

H. Blender Section

d. Provide a blender/air mixer section to provide for proper air mixing and distribution of outside air and return air streams, so as to minimize thermal stratification. Provide proper upstream and downstream spacing for optimum performance.

I. Mixing Box Section

e. Provide outside air and return air economizer mixing box section with motorized control dampers and inlets.
f. Provide mixing box with low leak dampers. Low leakage dampers shall have airfoil blades. Flat or formed metal blades are not acceptable. The damper blade shall incorporate rubber edge seals and zinc plated tubular steel shaft for a non-slip operation. Shaft bearings holes shall be N.C. machine punched and fitted with one inch O.D. heavy duty nylon bearings to eliminate friction and any metal to metal contact. Damper jamb seals shall be stainless steel spring arcs designed for a minimum air leakage and smooth operation. Damper linkage shall be concealed within a 16 gauge G-90 galvanized steel frame.

19. Damper Actuators
a. Provided and installed under Section 23 09 23 Temperature Controls.

J. Roof Curbs:
b. Roof curb shall be delivered to jobsite in an unassembled, knockdown state.
c. Curb shall be constructed of 14-gage G-90 galvanized steel, height to be minimum of 12" above top of roof insulation.
d. Full perimeter wood nailers shall be securely mounted to curb sheet metal.
e. Curb channel supports will be supplied on all curbs exceeding 10 ft in total unit airway length.
f. Gasketing between curb and unit shall be shipped for field installation with the unit curb.
g. Coil connection housing curb will be offered optionally to enclose coil piping. Multiple coil connection housings may be specified (up to two per side).
h. Curb shall be coordinated with roof slope at installed location. Curb construction to accommodate roof slope.
i. Curb shall be designed to accommodate piping vestibule as required.

K. Hoods:
20. Outside Air Hoods:
a. Outside air hoods shall be constructed of 20-gage galvanized G-90 steel and sized for 100% of unit nominal cfm.
b. Hoods shall include easily accessible 1-in. moisture eliminators with a maximum velocity of no more than 500 fpm.

21. Exhaust Air Hoods:
a. Exhaust air hoods shall be constructed of 16-gage galvanized G-90 steel and shipped collapsed in place.
b. Expanded metal bird screen shall be provided to prevent entry of unwanted materials into air handler.

L. Lights:
c. Marine lights with protective metal cage and glass seals, shall be installed inside each accessible section. A rotary timer light switch, 0-60 minutes, shall be provided on the outside of the unit. Electrical power shall be 120V/1/60. Lights shall be equipped with compact fluorescent bulbs. Wiring shall be in rigid EMT conduit.

M. Electrical and Controls:
d. Provide and mount an external junction box with motor leads extended through conduit for field wiring. Motor and lighting circuits shall be pre-wired at the factory. External disconnect devices by Division 26 – Electrical.
e. Provide single point power connection and additional circuit for lighting.
f. All controls by DDC contractor (no factory controls).
g. Provide unit with high static limit shutoff controls.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air-handling units with the following vibration-control devices. Vibration-control devices are specified in Division 23 Section "Mechanical Vibration Controls."
   1. Units with Internally Isolated Fans: Support on curb bases using neoprene pads.
B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
C. Install units on a flat surface level within 1/8 inch and of sufficient strength to support the unit.
D. Install in strict accordance with manufacturer's requirements, shop drawings, and Contract Documents.
E. Contractor shall include in their bid all labor and materials necessary to install air handling units (i.e. work resulting from shipping splits, etc).
F. Coordinate with air handling unit manufacturer all field work required with each air handling unit. This shall include all work required by other trades (i.e. electrical, controls, pipe fitters, sheet metal, structural, etc.) necessary to complete the installation of the air handling units.
G. Coordinate electrical installation with electrical contractor.
H. Coordinate controls with control contractor.
I. Provide all appurtenances required to ensure a fully operational and functional system.
J. Fan mounted Air Measuring Stations to be factory provided under this section of specification. Coordinate control interface with Section 23 09 23.
K. Damper actuators noted on Temperature Control Diagrams shall be factory mounted on unit in accessible locations. See Section 23 09 23 for actuator specification. Control wiring shall be performed in field by division 23 09 23.

3.2 CONNECTIONS
A. On units without internally isolate fans, install flexible connections between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum 1inch flex between ductwork and fan while running
B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
C. Install piping adjacent to machine to allow service and maintenance.
D. Connect condensate drain pans using Type M copper tubing. Extend to nearest equipment or floor drain. Construct trap at connection to drain pan and install cleanouts at changes in direction.
E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection.
F. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.
G. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
H. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.3 COORDINATION
A. Coordinate installation of variable frequency drives with Section 23 09 26 and Div. 26.

3.4 START-UP
A. Factory Start-Up Services: Start-up is to be supervised by the unit manufacturer or a manufacturer certified service organization. Physical connections and start-up are provided by the installing contractor. Start-up services shall be provided for as long a period of time as is necessary to ensure proper operation of the unit. The start-up engineer shall conduct such operating tests as required to ensure that the unit is operating in accordance with design. Complete testing of all safety and emergency control devices shall be made. The start-up engineer shall submit a written report to the owner and manufacturer containing all test data recorded as required above and a letter certifying that the unit is operating properly.
B. Operation and Maintenance Manuals: Manual shall be provided complete with descriptive literature, model, and serial number of all equipment, performance data, manufacturer's

instructions for operating and maintenance, lubrication recommendation and schedule, and winter shutdown procedure.

3.5 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 73 13

SECTION 23 81 27 - DUCTLESS SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes split-system heat pump air-conditioning units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting.

1.2 SUBMITTALS

A. Product Data: For each unit indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Operation and maintenance data.

1.3 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. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace split-system air-conditioning units that fail in materials and workmanship within five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

1. Mitsubishi, Inc.
2. Trane Co.
3. LG
4. Samsung

2.2 EVAPORATOR-FAN UNIT

A. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

B. Evaporator Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

C. Fan Motor: Multi-speed.

D. LEED Credit EQ 3.1 requires minimum MERV-13 filters. Verify availability of MERV-13 filters with rooftop unit manufacturers.

E. Filters: 1 inch thick, in fiberboard frames.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER UNIT

A. Casing steel, finished with baked enamel, 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.

B. Compressor: Hermetically sealed reciprocating or scroll type with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
C. LEED Credit EA 4 awards a single point if all HVAC&R equipment has HCFC-free refrigerant. R-407C and R-410A are HCFC-free refrigerants.
D. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
E. Fan: Aluminum-propeller type, directly connected to motor.
F. Motor: Permanently lubricated, with integral thermal-overload protection.
G. Low Ambient Kit: Permits operation down to -10 deg F.
H. Reversing Valve

2.4 ACCESSORIES
A. Microprocessor controls.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

3.2 CONNECTIONS
A. Install tubing to allow access to unit.
B. Install piping adjacent to unit to allow service and maintenance.

3.3 FIELD QUALITY CONTROL
A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
B. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new components, and retest.
D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 COMMISSIONING
A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 81 27

SECTION 23 82 19 - FAN COIL UNITS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes fan-coil units and accessories for indoor applications.

1.2 SUBMITTALS
A. Product Data: Include construction details, materials, finishes, rated capacities, operating characteristics, furnished specialties, and accessories.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required service clearances, method of field assembly, components, and location and size of each field connection.
   1. Fan Curves.
   2. Coil Capacity Data.
   3. Sound Data.
   4. Wiring Diagrams: Motor ratings, power, disconnects and control wiring.
C. Field quality-control test (start-up) reports.
D. Installation, operation and maintenance data.

1.3 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. NFPA Compliance: Fan coil units and components shall be designed, fabricated, and installed in compliance with NFPA 90A. “Installation of Air Conditioning and Ventilating Systems.”
C. Agency Certification: Fan coil units and their components shall be factory tested in accordance with UL 1995 and shall be sent to ETL for testing.
D. Comply with NFPA 70.

1.4 EXTRA MATERIALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: (One) spare set for each fan coil unit. (See Section 23 41 00 – Air Filters.)
   2. Fan Pulleys: Allow for one replacement size adjustable pitch pulley for each fan coil for use during system balancing to adjust air flow.

1.5 WARRANTY
   1. Units shall be provided with a minimum 12 month warranty, labor and material, (upon initial startup) for equipment defective in material or workmanship or 18 months from the date of shipment, whichever occurs first.

PART 2 - PRODUCTS

2.1 FAN COIL UNITS
A. General:
   1. Fan coil units shall be factory assembled and consist of fans, motor and drive assembly, coils, filters (except where external filter housings are indicated), condensate drain pans, cabinet, access doors, wiring and accessories.
   2. Fan coils units shall be horizontal or vertical configuration as indicated.
   3. Field verify unit configurations for left-hand or right-hand service access prior to submitting shop drawings.
   4. All units shall be of blow-thru or draw-thru design with coils, motor, blower and drain pan assembly completely within the cabinet enclosure.

5. Units shall be ETL Listed in compliance with UL/ANSI Standard 1995.

B. Configuration:
   1. Horizontal Units: Concealed above-ceiling mounted units complete with metal cabinet, including coils, belt or direct drive blower section and sloped stainless steel drain pan.
   2. Vertical Units: Exposed units with metal cabinet, including coils, belt or direct drive blower section and sloped stainless steel drain pan.
   3. Field verify unit configurations for left-hand or right-hand service access prior to submitting shop drawings.
   4. Verify unit voltage with electrical plans and schedules before submitting shop drawings. Where discrepancies between mechanical and electrical plans exist, contact A/E for direction before proceeding.

C. Construction:
   1. Manufacturers:
      a. York/JCI
      b. Envirotec
      c. Trane
      d. Thermal/Nailor
      e. Prior Approved Equal.
   2. Unit structural members shall be manufactured of heavy gauge, galvanized metal, or aluminum tubes with polymeric corners. Casing sections and access door shall be minimum 1" thick double wall construction, manufactured of minimum18 gauge pre-painted, galvanized sheet metal with 1" thick fiberglass insulation. Manufacturer's option to use sandwich wall panels with injected polyurethane insulation system.
   3. Access to blower and filter section shall be through a hinged access door with a quarter turn latch. Tool-less entry is required.
   4. Removable panels shall allow access to all other unit compartments.
   5. Access/maintenance shall all be from the front of the unit.
      a. Provide extended lube lines as required.

D. Direct Drive Blowers:
   1. All direct drive blowers shall be SWSI backward inclined type plenum fans, mounted directly to the motor shaft.
   2. Motor and fan assembly shall be statically and dynamically balanced.
   3. Blower and motor assembly shall be isolated from unit cabinet.

E. Direct Drive Motors:
   1. Direct drive motors shall be electronically communicated (EC) type.
   2. Factory wired to unit junction or control box.
   3. Motor protected with internal thermal overload.
   4. Motor bearings shall be provided pregreased (permanently lubricated).
   5. Motor Speed Controllers
      a. Single phase ECM motors shall be controlled by a unit mounted and pre-wired ECM variable speed controller (potentiometer) wired to receive an external 0-10V control signal from the BAS.

F. Hydronic Coils:
   1. All coils shall be fabricated of seamless copper tubes with aluminum fins mechanically bonded to the tubes. Headers on the coils shall be extra heavy wall seamless drawn copper tubing with die formed end closures for added strength, brazed joints.
   2. Coils have 1/2 inch O.D. copper tubes with aluminum fins mechanically bonded to the tubes. All coils are leak tested under water and are suitable for design working pressures of 250 psig @ 200 degrees F.
   3. Vent connections shall be provided at the highest point on the header. Provide with miniature manual vent valve.
   4. Drain connections & miniature drain valves (spill to condensate drain pan) shall be provided at the lowest point on each header. Where header drains are not provided, external drain valves with hose connections may be installed.

G. Condensate Drain Pan:

1. All units shall have a sloped condensate drain pan with a connection provided on each side of the unit. Drain pan shall be provided with either dual outlet connections; one lower connection for normal condensate flow and one higher, overflow connection, or with a secondary drain pan inside the unit with it's own outlet connection.
2. The condensate drain pan shall be fabricated from stainless steel and insulated with closed cell, fire retardant, foam insulation.

H. Water Coil Connections:
1. Provide 12" flexible braided stainless steel hose connector (Flow Design Inc Model S2 or approved equivalent) at each pipe connection (4 total) to the fan coil unit.

I. Electrical Connections:
1. Each unit shall have a single point power connection terminal black for field connection to the electrical power source.
2. When a separate motor starter/disconnect switch is not otherwise provided by Div. 26 (see Electrical drawings) each unit shall include a 24 volt control circuit transformer and a fan contactor for operation of the blower motor.
3. All internal wiring shall be color coded and a laminated wiring diagrm shall be permanently affized to the inside of the unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Install fan-coil units to comply with NFPA 90A.

B. Suspend horizontal fan coil units from upper structure with hanger rods and elastomeric vibration isolators. Mount vertical fan coil units on 4" tall C-Channel frames or base assembly as detailed on the drawings. Set on neoprene isolator pads. Secure to floor.

C. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
1. Install piping adjacent to unit to allow service and maintenance. Do not block filter removal clearance space.
2. Connect condensate drain & overflow drain lines and run to to indirect waste receiver or floor drain.
a. Install condensate P-trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

D. Coil Connection:
1. Provide 12" flexible braided stainless steel hose connector (Flow Design Inc Model S2 or approved equivalent) at each pipe connection (4 total) to the fan coil unit. Install flex connector in a straight line or with large radius offsets that do not kink. Piping to be rigidly supported so that flex connector does not carry load or cause adjacent piping to sway.
2. Coil connections shall be made-up with flanges (2-1/2" and larger) or unions with male copper sweat adapters and brass couplings. Female type copper sweat adapters shall not be used due to their tendency to crush/deform/leak when worked with wrenches.

E. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

F. Install belt drive fan coil units to provide a minimum of 36" of side access (as indicated on drawings) to allow for removal of fan assembly for service.

G. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls. Provide low voltage controls in accordance with the temperature control drawings and submittals.
H. Ground equipment according to Division 26 Section “Grounding and Bonding.”

3.3 FAN COIL INSTALALATION MOCK-UP

A. At the beginning of the fan coil installation work, the project Engineer will identify a certain number and/or type (horizontal or vertical) of fan coils units that is to be installed first, in order to work out and validate service clearances, piping arrangements and filter management geometry.
B. Mock-up units shall be installed with all required final ductwork, piping, valving, power and control connections so that the configurations may be observed and critiqued.
C. The mocked-up units shall be witnessed by the Engineer and the Owner’s representative in order to determine if configurations of piping, ductwork, etc. are acceptable for unit access and service clearance (including adjacent walk-way clearances and clearances to adjacent units).
D. Where the mocked-up units are determined to be arranged in an unacceptable manner, or where service clearances are compromised, the mock-ups installations shall be reworked as determined by A/E, at no extra cost.
E. Results of acceptable mock-up configurations shall be the general basis for the installation of the remaining project units.

3.4 FIELD QUALITY CONTROL

A. Final checks before startup. Perform the following:
   1. Verify that unit is secure on mountings and supporting devices; and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnect switches.
   2. Perform cleaning and adjusting specified in this section.
   3. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts and install belt guards.
   4. Lubricate bearings, pulleys, belts, and other moving parts with factory recommended lubricants.
   5. Comb coil fins for parallel orientation.
   6. Vent air from coils.
   7. Install clean filters.
   8. Prime condensate drain P-Traps with water.
   9. Verify that manual and automatic volume control dampers in connected duct systems are in fully open position.
B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, fill water and steam coils with water and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
   2. Start-up & Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Provide field test start up report for each unit.
   3. Replace pulley sizes and belts if necessary to achieve proper air balance as deterimined by TAB contractor.
   4. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
C. Remove and replace malfunctioning units and retest as specified above.

3.5 CLEANING

A. Clean fan coil units internally, on completion of installation, according to manufacturer’s written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.
B. After completing system installation and testing, adjusting, and balancing vertical fan coil and air distribution systems, clean filter housings and install new filters.

3.6 DEMONSTRATION

A. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain vertical fan coil units. Refer to Division 1 Section Closeout Procedures and Demonstration and Training.

END OF SECTION 23 82 19

SECTION 23 82 36 - ELECTRIC HEATERS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes electric unit heaters, wall heaters and base board panel style heaters.

1.2 SUBMITTALS
A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
C. Plans, elevations, sections, and details.
D. Location and size of each field connection.
E. Field quality-control test reports.
F. Operation and maintenance data.

1.3 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.

PART 2 - PRODUCTS

2.1 ELECTRIC UNIT HEATERS AND WALL HEATERS
A. Manufacturers: Subject to compliance with req's, provide products by one of the following:
1. Runtal
2. Indeeco
3. Prior approved manufacturers: Raywall, Modine, Markel
B. Electric Unit Heater
1. Recessed wall with electric forced air heater and heavy gauge cabinet and decorative grilles.
C. Casing:
1. Cabinet: 16 gauge cabinet with tamper-proof removable panels for maintenance access to controls. Sloped top design.
2. Cabinet Finish: Manufacturer's standard baked enamel or powder coated finish. Color selected by Architect.
3. Discharge Louver: Fixed blade grille.
D. Coils:
1. Circular copper clad steel sheathed element with continuously brazed steel fins, or nickel-chromium wire elements enclosed in powder filled aluminum coated steel tubes with spiraled fins. Elements shall be resistant to thermal shock and vibration.
E. Fan:
1. Multiple direct-drive scroll type fans on a common shaft.
F. Fan Motors:
1. Comply with requirements in Division 23 section "Motors".
2. Motor Type: Permanently lubricated.
G. Accessories:
1. Disconnect switch.
H. Controls:
1. Provide relay for DDC connection. See control diagrams on drawings and Specification section 23 0923.

2.2 ELECTRIC BASEBOARD HEATERS

1. Manufacturers: Subject to compliance with req's, provide products by one of the following:
2. Runtal
3. Indeeco

B. Rating: UL listed and labeled for mounting in wall and floor applications.

C. General:

1. Radiator units feature a flat radiant tube design to enhance system efficiency and provide aesthetic appeal. Flat radiant tubes to be manufactured from low carbon steel that are welded to end to steel square tube headers. Where indicated, flat panels shall be provided with supplemental convective fins for increased heat transfer output. Headers will contain all supply, return and air vent connections required.

D. Construction:

1. All radiators shall be degreased and chemically phosphatized before the application of a durable, 2 to 3 mil thick electrostatic polyester epoxy powder coat finish. Color to be selected from standard color chart.

E. Accessories:

1. Provide required factory wall mounting brackets and nylon silencer material for noise free operation. Mounting brackets to allow for continuous mounting and unhindered expansion and contraction.

F. Capacities and Characteristics:

1. See schedule on drawings.

G. Controls:

1. Provide relay for DDC connection. See control diagrams on drawings and Specification section 23 0923.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install heaters to comply with NFPA 90A.

B. Comply with safety requirements in UL 1995.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

B. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

C. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

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

3.3 COMMISSIONING

A. Selected equipment and systems are to be commissioned per Section 01 9113 - General Commissioning Requirements and Section 23 0800 – Mechanical Systems Commissioning. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 23 82 36

DIVISION 26 – ELECTRICAL

SECTION 26 0010 - GENERAL PROVISIONS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the contract, including General and Supplementary Conditions, Division 01 Specification sections, apply to this section.

1.2 SUMMARY

A. Section includes:
   1. Definitions and Abbreviations
   2. Contract documents
   3. Alternates
   4. Code requirements
   5. Permits & fees
   6. Submittal requirements
   7. Prior approval substitution request
   8. Schedule of values
   9. Warranty
   10. Construction phasing
   11. Project closeout requirements

B. DEFINITIONS AND ABBREVIATIONS

ADA	Americans with Disabilities Act
Ampacity	Capacity expressed in amperes
ASTM	American Society for Testing & Materials
Concealed	Hidden from sight as in trench, chases, slabs, furred spaces or ceilings
Contractor	Shall mean the General Contractor who signs the contract with the
Owner	Pasco School District No. 1
EMT	Electrical Metallic Tubing
Exposed	'Not concealed' as defined above
Furnish	Supply
Galv.	Galvanized
IBC	International Building Code
IEC	International Energy Code
IFC	International Fire Code
IEEE	Institute of Electrical & Electronic Engineers
IPCEA	Insulated Power Cable Engineers Association
Indicated	Indicated on Divisions 1-33 drawings or specifications
Install	Install or apply
L&I	Labor and Industries
Mfg.	Manufacturer
NBFU	National Board of Fire Underwriters Pub. 70 (latest edition)
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NREC	Non-Residential Energy Code
Provide	Furnish and install
UL	Underwriters Laboratories, Inc.
WAC	Washington Administrative Code
WSEC	Washington State Energy Code
WISHA	Washington Industrial Safety Health Act

1.3 CONTRACT DOCUMENTS

A. It is the intention of the Division 26 Contract Documents to provide complete and fully operational electrical systems for lighting, power and equipment connections hereinafter specified and/or as shown on the drawings. The work shall include all materials, appliances and apparatus not specifically mentioned herein or noted on the plans, but which are necessary to make a complete working installation.

B. All electrical systems, mounting hardware, labor and other items indicated on the Division 26 drawings, schedules and/or in the specifications shall be included in the Contractor's bid, unless specifically indicated otherwise. The specifications, schedules, diagrams, details and plans are complementary and what is indicated on any is as binding as if indicated on all. Where a conflict exists between what is shown and what is specified, the more stringent shall govern.

C. The contract drawings indicate the extent and the general character and approximate location and arrangement of material and equipment. The documents do not necessarily show the total number of conductors, raceways, boxes, support, access panels, actual routing, block outs, exact device or equipment locations or other such detailed information for the work required. The Contractor shall provide all necessary materials as required by applicable code and product specification for a complete and fully operational installation in accordance with the true intent of the drawings and specifications.

D. All dimensions indicated in the Division 26 drawings are approximate and are indicated as a guideline only. The Contractor shall adjust the exact rough-in locations as necessary to avoid conflict with structural components or other materials and to assure that fixtures, devices, boxes, etc., can be installed as close to the intended location as possible. Working measurements shall be taken from the building and checked with the Architectural and Structural drawings. If conflicts are found the Contractor shall request verification from the Architect before proceeding with that work.

E. The Division-26 documents do not separate work or responsibilities of sub-contractors. The General Contractor is responsible for defining the scope of work of each contractor. This specification recognizes only one contractor. That is the General Contractor who signs the contract with the Owner. Where the term 'The Contractor' is used, it applies to the contractor responsible for the installation of the work described.

1.4 **ALTERNATES** (SEE SPECIFICATION SECTION 01 23 00 3.1 – SCHEDULE OF ALTERNATES)

1.5 CODES

A. The installation of this work shall comply in every way with all governing codes, laws, ordinances and rules applicable to the City of Pasco, Washington.

B. If any conflict occurs between these rules and this specification, the rules shall govern. Nothing in these drawings and specifications shall be construed to permit work not conforming to governing codes. This shall not be construed as relieving the Contractor from complying with any requirements of the plans or specifications which may be in excess of requirements of hereinbefore mentioned rules and not contrary to same.

1.6 PERMITS & FEES

A. Obtain and pay for all licenses, permits, registration fees and inspections required by laws, ordinances and rules governing the work specified herein. Arrange for inspection of the work by inspectors and give the inspectors all necessary assistance in their work of inspection.

B. The Contractor shall include in their bid all utility company fees for temporary service work related to the project in their bid. Utility company fees for permanent power & communications shall be paid for by the owner. The serving utility companies for this project site are Franklin PUD (power) and (fiber optic); Century Link (telephone); Charter (CATV).

C. The Division 26 bid shall include all Labor and Industries permit, inspection, licensing, registration or any other fees associated with the work specified under this Division.

1.7 SUBMITTALS

A. It is understood that before the manufacture or installation of any of the work under this contract is carried forward, shop drawings of such work shall be submitted for review.

B. Electronic Submittal Files: Electronic (PDF) files may be submitted. Individual PDF files shall be required for each specification section and shall be named to identify each section & content (i.e. 26 2413 Switchboards). Where multiple files are required due to size, number the files in sequence (i.e.: 26 2413 Switchboards1). Submittals shall be routed through proper channels or if acceptable to the Architect, transmitted via e-mail with a tracking transmittal delivered through proper channels. Reviewed submittals shall be returned on any of the above described formats or methods.

C. Submittals and shop drawings shall be submitted in ample time to avoid delay in any of the work. To ensure there is sufficient time for review, the Contractor shall allow for 15 work days (M-F) minimum for the transportation, review, processing and return.

D. Submittals shall be delivered to the Electrical Engineer via the routing channels specified in Division 1 or established by the Project Manager and/or Architect.

E. A submittal log shall be provided by the contractor for tracking purposes that lists all submittals intended to be reviewed. This log shall list each item to be reviewed, specification section appropriate to the material, a date received column, a review result column and a date returned column. The date and review columns shall be blank and are for the Engineer's use. Returned submittals will include a filled in copy of this log.

F. Items requiring immediate attention due to long lead delivery time or for early construction rough-in are to be identified and shall be submitted in advance of the remainder of the submittal to ensure delivery will coincide with the construction schedule.

G. Contractor Review: Prior to forwarding to the Architect, the Contractor shall review the submittals; mark them with their comments, corrections and approval stamp. The Contractor shall verify that all of the specified requirements are indicated and ensure that the intended items have been identified on the submittal. Submittals shall be clearly marked as to which items, options, colors; models, etc. are being provided. Only the items marked or indicated will be considered as being submitted. If no marks or indications are present on a page only the items conforming to these specifications will apply. Contractor's installing unspecified material will replace that material at their own expense, if in the opinion of the Architect or Engineer that it does not meet specifications, at any time throughout construction. Indicate additional information necessary for the Architect and Engineer to determine the Contractor's intention, color selection, equipment options, etc.

H. Architect and Engineer review: The Architect & Engineer's review of the submittals/shop drawings is intended as a check for general conformance with contract documents only. Failure by the Architect or Engineer to discover an error on a submittal does not relieve the contractor of the responsibility for compliance with requirements of the drawings and specifications.

I. Upon request from the Architect or Engineer, provide material samples for examination, color selection and/or quality control. These samples shall be delivered to the Architect's or Engineer's office as directed.

J. The Architect and Engineer's review of the submittals/shop drawings is intended as a check for general conformance with contract documents only. Failure by the Architect or Engineer to discover an error on a submittal does not relieve the Contractor of the responsibility for compliance with requirements of the drawings and specifications.

K. For material requiring color or finish selection 'by Architect', provide separate copies marked 'ATTENTION (ARCHITECTS NAME) – COLOR/FINISH SELECTION REQUIRED'.

L. Provide submittal material as described in Part 1 of each specification section.

26 0519	Low-Voltage Electrical Power Conductors and Cable
26 0526	Grounding & Bonding Material
26 0529	Hangers and Supports for Electrical Systems
26 0533	Raceway and Boxes for Electrical Systems

26 0534	Surface Raceway for Electrical Systems
26 0573	Overcurrent Device Coordination Study
26 0913	Power Monitoring and Control for Electrical Systems
26 0923	Lighting Control Devices
26 0943	Network Lighting Controls
26 2200	Low-Voltage Dry-type Transformers
26 2419	Automatic Power Factor Correction Capacitor
26 2413	Switchboards
26 2416	Panelboards
26 2726	Wiring Devices
26 2813	Fuses
26 2816	Enclosed Switches and Circuit Breakers
26 2820	Elevator Power Modules
26 2933	Mechanically Held Contactors
26 5100	Lighting Fixtures

Division 27: See section 27 0010 for material submittal requirements.
Division 28: See section 28 0010 for material submittal requirements.

1.8 PRIOR APPROVAL SUBSTITUTION REQUEST

A. Items specified are basis-of design and intended to represent quality and general requirements. It is not the intent of these specifications to prohibit other manufacturers from submitting on substitute materials for review as an acceptable equal. Approval granted for substitution requests is made under the assurance that the manufacturer, vendor or sales representative guarantees that the substituted product meets or exceeds the minimum requirements of the specified product.

B. To ensure ample time for review, evaluation and publishing (by addendum), substitution requests must be submitted no later than ten normal business days prior to the bid. Submittals received less than ten normal business days will be at risk of not being published and allowed to bid.

C. Vendors seeking prior approval shall include system certifications in their submittal.

D. If prior approval has not been requested and granted, then the product manufacturer shall be as specified in the contract documents. The Architect/Electrical Engineer reserves the right to reject any product that has not been prior approved or specified.

E. The Contractor shall be responsible for checking equipment dimensions of proposed substitute equipment and be responsible for it fitting the space allowed.

F. Approval of substitution requests are granted with the understanding that any additional cost involved with the installation, re-design or replacement of the substituted material (as a result of the unacceptable performance of that product) shall be paid for by the Contractor.

G. Approved substitutions will be listed in Addenda. Any item listed by addenda may be provided under this contract. Substitution items not listed by Addenda are rejected and shall not be allowed to bid.

H. Substitution after the bid will only be allowed for any one of the following reasons:
   1. The Architect, Engineer and Owner approve the substitute product as a better product at no increased cost.
   2. The substitute product is approved as an equal by the Architect, Engineer and Owner and a credit is offered to the Owner. Reference Division 01 documents for substitution request procedures.
   3. The reason for unavailability is discontinuance by the manufacturer.

1.9 SCHEDULE OF VALUES

A. Within 30 days of the 'Notice to Proceed' the Contractor shall furnish a breakdown of the Division 26 work as indicated in the following Schedule of Values:
   Mobilization

Site Electrical, Material
Site Electrical, Labor
Branch Wiring & Equipment Connections, Material
Branch Wiring & Equipment Connections, Labor
Feeder, Material
Feeder, Labor
Power Distribution Equipment, Material
Power Distribution Equipment, Labor
Lighting Fixtures, Material
Lighting Fixtures, Labor
Lighting Control, Material
Lighting Control, Labor
Demobilization & Closeout

Division 27: See Section 27 0010 for SOV requirements
Division 28: See Section 28 0010 for SOV requirements

1.10 WARRANTY AND CORRECTION PERIOD

A. All products provided under Division 26 shall include the manufacturer's standard warranty.

B. In addition to the manufacturer's standard warranty the Contractor shall guarantee the satisfactory operation of all material, equipment and installations provided under this specification and make good, repair or replace, as may be necessary, any defective work, materials or equipment which fail or become defective within a one year period beginning on the date of substantial completion as established by the Owner and Architect.

C.

PART 2 - PRODUCTS

1.1 MATERIAL REQUIREMENTS

A. All materials shall be new and must be equal to the quality herein specified and as shown on the drawings or a reviewed and accepted equal.

B. All materials furnished shall be tested and approved for the purpose for which they are used, by a Washington State Labor & Industries approved NRTL facility such as Underwriters Laboratories, Inc.

C. All materials furnished shall be of the standard products of manufacturers regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design.

D. All materials furnished shall be manufactured in accordance with applicable standards of NEMA, ANSI and listed by an approved NRTL.

E. Provide the materials specified unless a product has been discontinued or revised in which case provide the manufacturer's equivalent product replacement.

F. All material shall be provided and installed per the requirements for seismic zone D.

PART 3 - EXECUTION

1.1 INSTALLATION

A. Workmanship shall be of the best quality and none, but competent mechanics shall be employed and shall be under the supervision of a competent foreman. All work shall be complete and present a neat and symmetrical appearance. Non-professional workmanship shall be removed and replaced if so directed by the Architect at no additional cost to the Owner.

B. All work and materials shall be subject to inspections at any and all times by representatives of the Owner and/or Architect.

1.2 WORK NOT INCLUDED

A. Mechanical equipment and control wiring unless specifically indicated as provided by Division 26.

1.3 ELECTRICAL PHASING REQUIREMENTS

A. Construction phasing unless specifically indicated in the architectural drawings or specifications is the responsibility of the General Contractor.

1.4 EXAMINATION OF SITE

A. Before submitting bids, all bidders on Division 26 work shall visit the site to satisfy themselves as to the nature and scope of all work to be done. The submission of a bid will be taken as evidence that such an examination has been made and difficulties, if any, noted. Later claims for labor, work, materials and equipment required for any difficulties encountered which could have been foreseen, will not be recognized and all such difficulties shall be properly taken care of at no additional expense to the Owner.

1.5 UTILITIES

A. It shall be the contractor's responsibility to coordinate and confirm all aspects of the utility service. work to the building with the serving utility companies listed below. The contractor shall verify the requirements indicated on the documents are accurate and meet all utility requirements prior to beginning any utility work.

B. The serving utility companies are as follows:
   1. Power: Franklin PUD; 509/542-5347, Wayne Redin
   2. Fiber: Franklin PUD; 509/542-5366, Brent Weatherman or Ben Hooper
   3. Telephone: Century Link; 509-305-7503, Tobias Mears

1.6 MEETINGS AND FIELD OBSERVATION

A. A representative of the Electrical Consultant shall attend monthly construction coordination meetings and conduct an observational walk-through.

B. At the time of monthly walk-through, the project foreman shall (upon request) accompany the observation party, and remove cover plates, panel covers, ceiling tiles, access panels and unlock doors for the Electrical Consultant, to allow complete observation of the entire electrical system in an efficient manner.

C. The Contractor shall provide all ladders, tools, and hard hats required by the Electrical Consultant. The Contractor shall open any switchboard, panel, box, etc. as requested for the Architect/Engineer's inspection.

D. The Contractor shall bring the red-line (mark-up) set of Record Drawings to each monthly meeting attended by the Electrical Consultant for review.

1.7 PROJECT CLOSEOUT

A. Prior to final acceptance of the project the Contractor shall provide Division 26 record drawings and operation and maintenance manuals (O&M) for all work included in this contract.

B. Record drawings shall indicate all corrections and changes made during the construction and shall be neatly and legibly recorded on a set of prints and specifications. Record drawings shall be readily available at the project site for Architect and Engineer progress review. All changes to the

Bid Documents shall be recorded by the Contractor at the time they occur and approved prior to implementation. The information to be documented shall include, but is not limited to, the following:

1. Provide accurate locations of all underground site electrical conduit and/or direct burial cable, all service or 100A and higher feeder conduits located below slab within the building and all concealed risers within walls. Indicate dimensions in reference to the building and other landmarks. Indicate burial depth.
2. Indicate the route of all feeders concealed risers for switchboards, panelboards and/or equipment rated 100A or higher.
3. Indicate all branch circuit revisions including home run locations, circuits assigned to each device or fixture and changes to location.
4. Revise all panel schedules to indicate circuit and load revisions.
5. Indicate all revisions to the configuration and/or locations of switchgear, switchboards, transformers, panelboards, etc.
6. Indicate any revision to the power distribution architecture on the one-line and/or riser, including section bus amperage or feeder size, disconnecting device type, or other changes made to the designed arrangement.
7. Indicate locations of all access panels and above ceiling electrical equipment such as remote LED drivers, lighting control modules, bridges, relays, power supplies, etc.
8. Indicate all revised device locations.
9. Update all room numbers and nomenclature on every floor plan and reference with the permanent (end user) names and numbers assigned by the Owner.
10. Stamp, print or otherwise mark ‘Record Drawing’ on each sheet of the electrical plans. Mark the specification cover sheet with ‘Record Copy’.

C. O&M Manuals: Prior to the completion and final acceptance of the contract, the Contractor shall prepare Operating and Maintenance Manuals describing the maintenance and periodic testing requirements of the electrical systems and equipment provided under Division 26. The accepted O&M manuals shall be presented to the Owner at the time of the Owner training and demonstration. Provide manuals as follows:
   1. Information contained in the manual shall consist of 8-1/2” x 11” or folded 11”x17” size catalog data, parts list, programming instructions, operation, maintenance, shop drawings, wiring and diagrams installed in a three-ring binder.
   2. Catalog data in the manuals shall be neat, clean copies. Full size shop drawings too large for the submittal binder shall be added to the As-Built set.
   3. An index shall be provided, which lists all contents in an orderly manner. Tab dividers shall organize all components into logical categories.
   4. The binder(s) shall be identified on the cover and binder face with ‘Electrical O&M Manuals for [Project Name], [Date], and [Volume No. of No.]’.
   5. DVD with electronic files of O&M materials.

D. The O&M Manuals shall include the following:
   1. Indicate the vendor, sub-contractor or distributor who supplied each system or material.
   2. Submittal data
   3. Manufacturer’s Shop Drawings
   4. Manufacturer’s installation, adjusting, programming and maintenance instructions for lighting control systems & devices
   5. Provide copies of the electrical inspection sign-off sheets by the electrical AHJ, Department of Labor and Industries or the appropriate municipal authority having jurisdiction

E. At substantial completion, provide one set of legibly marked-up record documents to the Electrical Engineer for review and comment. Incomplete or unintelligible documents will be returned to the Contractor if deemed by the Engineer not to reflect As-Built conditions. Upon acceptance of the Record Document markups, the Engineer will provide copies of the AutoCAD files to the Contractor for final drafting. It shall be the Contractor’s responsibility to transpose the Record Drawing information into the AutoCAD files. The Contractor shall employ a drafting service or at their option, the Electrical Consultant to update the ACAD files. Drafting services performed by Coffman Engineers will be billed at the current hourly rate. Include drafting service fees in the Division 26 Bid and provide the Engineer with a clean set of corrected prints for final review.

F. At substantial completion, provide electronic files of all O&M material for review. Materials shall be reviewed, and a review letter provided back to the contractor. The contractor shall provide all additional items listed in the review letter prior to delivering the O&M manuals to the owner.

G. The Contractor shall make changes or revisions to the record copy of the panel schedules by hand. Blank copies or PDF file blank copies will be made available to the contractor. Original spread sheet files will not be provided.

H. After acceptance of the corrected documents the Contractor shall provide to the owner (PSD) and Electrical Engineer (1) complete set of Division 26-27 drawings including the updated vendor shop drawings on 24”x36” bond paper and a complete set of AutoCAD & PDF files, one file per sheet and a complete bound set of PDF files including all sheets.

I. The Contractor shall deliver the record documents through proper channels.

J. Owner Training: After the electrical systems are completed, tested and operational and before final acceptance of the electrical work, an indoctrination and instructional period of operating personnel shall be set up. The following is required:
   1. The Contractor shall schedule all equipment factory representatives and subcontractors together for system start-up and Owner instruction.
   2. The instruction period shall include discussion and presentation of the O&M manuals with tours of equipment locations, explaining access, servicing, maintenance, programming, cleaning, re-lamping procedures, adjustments, etc., for the Owner’s signature of acceptance.
   3. Tour facility to orientate the Owner with the location of the main service and distribution gear and all branch panel locations. Indicate where all control relays, lighting control modules, dimmers, inverters, remote LED drivers, power supplies, etc. are located above ceilings. Show the owner where all access panels for Division 26-28 equipment are located.
   4. Demonstrate how to identify a ‘trip’ condition and how to reset main and branch distribution circuit breakers.
   5. Lighting Fixtures: Demonstrate lamp, louver, ballast, and fuse replacement on all similar type fixtures.
   6. Surge Protection: Demonstrate the locations, check for defective units and testing procedures.
   7. Lighting Control Systems: Demonstrate control method, programming adjustments, sweep-off time, bypass feature, bypass locations.
   8. The Contractor’s representative shall be fully knowledgeable of the project and equipment involved. The Contractor shall schedule, organize and supervise all demonstrations. Schedule the demonstrations for all systems supplied by any one vendor to run consecutively.
   9. Upon completion of each system demonstration obtain a sign-off from the Owner’s authorized representative, stating that the system was demonstrated to be fully operational and complete. Indicate the duration of each instructional period per system. Send copies to the Owner, Architect and Electrical Engineer.

K. Prior to final acceptance, the Contractor shall notify the Engineer one week in advance of the date for the Division 26 punchlist. All material and equipment provided, installed or connected under Division 26 shall be completely installed and operational prior to the scheduled punchlist date. If it is the opinion of the Electrical Engineer that the project is not complete at the time of the scheduled punchlist, the Contractor shall bear the full cost for any additional trips that are required due to incomplete work or non-functional systems. Additional trips will be billed at the customary hourly rate. Upon receipt of the punchlist, the Contractor shall complete all items noted as requiring correction. One additional trip will be allowed to verify that all punchlist items have been completed on a date mutually agreed upon by the Contractor, Owner, Architect and Engineer.
   1. The Contractor shall leave the job in complete order ready for use. All refuse shall be removed. All fixtures, devices and equipment shall be secure, fully equipped, completely cleaned and in good working order. The Owner’s Maintenance and Operational personnel shall be thoroughly indoctrinated in the maintenance and operation of electrical systems provided under this Division. All spare and remaining items not used in the project but paid for by the Owner shall be delivered in like new condition to an on-site storage facility as directed by the Owner.

2. Commissioning Requirements in addition to those specified under Division 01 and 26. Provide functional testing of the lighting control systems per WSEC, C408.3.

END OF SECTION 26 00 10

SECTION 26 0500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the contract, including General and Supplementary Conditions, Division 01 Specification sections, apply to this section.

B. Division 07, Penetration Firestopping.

1.2 SUMMARY

A. Section Includes:
   1. Electrical equipment coordination and installation.
   2. Sleeves for cables.
   3. Sleeve seals.
   4. Grout.
   5. Access doors and frames
   6. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
   5. To maintain access and keep passageways clear.

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

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section ‘Access Doors and Frames’.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section ‘penetration Firestoppping’.

PART 2 - PRODUCTS

2.1 SLEEVES FOR CABLES

A. Above Grade Wall Sleeves for Cable: EMT conduit with nylon throat connectors and plastic bushing on each end.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway.

B. Manufacturers: Subject to compliance with requirements, provide comparable product by one of the following manufacturers:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex Co.
   4. Pipeline Seal and Insulator, Inc.

C. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, non-metallic aggregate grout, non-corrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 CONCRETE

A. Cast-in-Place concrete for Lighting pole bases, housekeeping pads, transformer pads, etc. shall be the responsibility of each section of Division 26.

B. Cast-in-Place concrete shall comply with Division 3 requirements.

2.5 ACCESS DOORS AND FRAMES

A. Access panels shall be the responsibility of each related section of Division 26. All access doors on the project are to be the product of one manufacturer and are to meet the requirements of Specification Section 08310. Closely coordinate the type of access doors and locations with all other Divisions.

B. Where required for access to hidden junction boxes or other Division 26 equipment, the doors shall be sized as necessary to provide proper working clearance.

C. Provide identification tags for all Division 26 access doors.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. All material and equipment shall be installed symmetrical, level, plumb, parallel and perpendicular to other building systems and components, except where otherwise indicated.

G. Devices shall be mounted in compliance with the Americans with Disabilities Act (ADA) or as specified within the limits described below.
   1. High forward reach limits, without obstruction; between 15” and 48”.
   2. High forward reach limits, with obstruction less than 20”; between top of obstruction and 48”.
   3. High forward reach limits, with obstruction between 20” & 25”; between top of obstruction and 44”.
   4. Clear floor space, parallel approach; between 9” and 54”.
   5. Side reach over a 24” wide by 34” maximum obstruction; 46”.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways penetrate floor and wall assemblies.

B. Sleeves through walls or floors, above grade: Use EMT conduit sleeves unless penetration arrangement requires rectangular sleeved opening.

C. Coordinate and comply with requirements in Division 07 Section ‘Penetration Firestopping’.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Fire-Rated Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

F. Cut sleeves to length for mounting semi-flush with both surfaces of walls.

G. Unless otherwise noted, extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

H. Seal space outside of sleeves and penetration opening with epoxy grout for concrete and masonry. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section ‘Joint Sealants’.

J. Aboveground, Wall Penetrations: Install steel EMT.

K. Underground, Exterior-Wall Penetrations: No sleeve required. Install PVC Schedule 40 conduit through wall and seal space between wall with masonry grout.

3.3 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section ‘Penetration Firestopping’.

3.4 CLEANUP

A. Removal of refuse, debris, cuttings, packaging, cartons, etc. for work provided under Division 26 shall be the responsibility of each related section of Division 26.

B. Cleanup shall be done continually during construction, at sufficient frequency to eliminate hazard to the public, occupants, workmen, the premise and adjacent property.

C. Before acceptance of the installation, carefully clean cabinets, panels, boxes, wiring devices, cover plates, etc., to remove dirt, cuttings, paint, plaster, mortar, concrete, etc. Blemishes to finished surfaces of apparatus shall be removed and new finish equal to the original applied.

3.5 TOUCHUP PAINTING

A. Touch up or repair of factory finishes that are scratched or marred in shipment or installation shall be the responsibility of each related section of Division 26.

B. Thoroughly clean damaged areas and provide primer, intermediate, and finish coats to suit the degree of damage at each location.

C. Follow paint manufacturer’s written instructions for surface preparation and for timing and application of successive coats.

D. Repairs shall be made to the satisfaction of the Owner and/or Architect.

3.6 SAFETY CONDITIONS

A. The Contractor will be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The duty of the Architect to conduct construction observations of the Contractor's performance is not intended to include review of the adequacy of the Contractor's performance measures, in, on, or near the construction site.

B. Furnish, erect and maintain all barricades, guard structures, warning signs, detour signs, lights and flares as may be required to protect and safeguard from injury or damage.

C. Provide bracing, scaffolding, guard rails and protective devices necessary to protect workmen and personnel from personal injury due to electrical installations while on the jobsite.

D. Contractor shall be liable for all damage and injury occurring to the Owner's property on or in the adjacent areas of the work, or which shall occur to any person or property whatsoever by reason of the negligence of the Contractor or any of his employees, or sub- Contractors, or of any breach or violation of the provisions of this agreement, or of any of his duties or obligations under the contract.

E. Temporary power used for construction shall be ground fault protected.

END OF SECTION 26 05 00

SECTION 26 0519 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the contract, including General and Supplementary Conditions, Division 01 Specification sections, apply to this section.

1.2 SUMMARY

A. This section includes the following:
   1. Building wires and cables rated 600V and less.
   2. Connectors, splices, and terminations rated 600V and less.

B. Related Sections include the following:
   1. Division 27 Section ‘Communications Cabling’ for cabling used for voice and data circuits.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Set sleeves or block-outs in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Subject to compliance with requirements, provide comparable product by one of the following manufacturers:
   1. Alcan Products Corporation; Alcan Cable Division.
   2. Encore Wire
   3. Cerrowire
   4. General Cable
   5. Houston Wire and Cable

6. Okonite
7. Prysmian
8. Republic Wire Inc
9. Southwire

B. Aluminum and Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN, XHHW & XHHW2.

D. Conductors larger than #2AWG shall be Type XHHW or THHN -THWN rated at 75 degrees only.

E. Minimum conductor sizes to be as follows:

Lighting and power branch circuits	#12 AWG Min
Control circuits for motors and generators	#14 AWG Min
Grounding Conductor	#12 AWG Min

F. Provide conductors with conductivity of not less than 98% at 20 degrees C (68 degrees F).

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC
4. 3M; Electrical Products Division
5. Tyco Electronics Corp.
6. Houston Wire and Cable Company

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type and class for application and service indicated.

2.3 ALUMINUM CONDUCTORS

A. Aluminum conductors shall only be used for feeders rated 100 Amps and larger. All other conductors shall be copper unless otherwise indicated on the drawings.

B. The Labor and Industries approved electrical documents are based on the use of copper or aluminum conductors as indicated. The contractor shall not substitute without prior approval from the engineer of record and Labor & Industries.

C. Aluminum conductors shall be compact stranded, AA-8000 series aluminum-alloy conductors equal to Alcan STABILOY.

D. Aluminum conductor ampacity shall be as shown in the 75-degree C column of NEC Table 310.16.

E. Prior to termination all exposed ends that contact compression lugs shall be cleaned and coated with an oxide-inhibiting compound.

F. Terminations on bus or lugs shall utilize one or two hole compression lugs.

G. All equipment requiring copper connections and feeders to meet UL Listing requirements or manufacturer's recommendations shall be fed from the overcurrent device to the unit with copper conductors. It shall be the contractor’s responsibility to verify that aluminum feeders are acceptable for the equipment being served with the manufacturer with the equipment manufacturer.

H. Splicing on copper pigtails on an aluminum feeder is prohibited.

2.4 CONDUCTOR SUBSTITUTION

A. The Labor and Industries approved electrical documents and all calculations for distribution feeders and circuits shown on the drawings are based on the conductors indicated. Deviation from the specified conductors is prohibited unless approved by the electrical engineer and the Washington State Department of Labor & Industries.

B. Final connections to all mechanical equipment shall be copper only.

2.5 MULTI-CONDUCTOR METALIC CABLE

A. Multiconductor Cable: Comply with NEMA WC 70 for armored cable, Type AC & metal-clad cable, Type MC.
    1. Cable shall be rated for the installed location. In wet, damp, or outdoor locations the cable shall be liquid-tight and rated for the environment.
    2. Neutral conductors shall be full size (equal to largest conductor), #12 AWG minimum. Multiple circuit cables shall include a full size dedicated neutral for each circuit.
    3. Cable shall include a ground wire.
    4. Use of MC cable is restricted to branch circuiting only; #12AWG. All other wiring shall be installed in a conduit system.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders for Distribution or Equipment: Copper, or aluminum for feeders rated 100A and larger. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Equipment Wiring: All final connections to mechanical and other equipment (where required by the manufacturer) shall be copper only.

C. Branch circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. Branch circuits, above grade, concealed and 30 amperes or less: Conduit with pulled in conductors or MC armorclad cable assemblies with copper conductors.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS.

A. Service Entrance: Type THHN-THWN or XHHW2, single conductors in raceway as indicated on the drawings.

B. Feeders: Type THHN-THWN or XHHW2, single conductors in raceway as indicated on the drawings.

C. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN or XHHW2, single conductors in raceway as indicated on the drawings.

D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN or XHHW2, single conductors in raceway or where allowed per this specification, Armored cable, Type AC or Metal-clad cable, Type MC.

E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN or XHHW2, single conductors in non-metallic raceway (PVC).

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Conduits and junction boxes shall be blown out and thoroughly cleaned before any conductors are drawn in. No wires or cables shall be installed until construction work which might damage insulation has been completed.

E. Install exposed cables parallel and perpendicular to walls, ceilings and surfaces of exposed structural members. Conceal all exposed cable from view and follow structural contours where possible.

F. Support cables according to Division 26 Section 'Hangers and Supports for Electrical Systems'.

G. Identify and color-code conductors and cables according to Division 26 Section 'Identification for Electrical Systems'.

H. All branch circuits shall be tagged with circuit number identification in all gutters, light fixture outlet boxes, device boxes (receptacle, outlet, switch, etc.) and in junction boxes. Feeders and mains shall be tagged in the switchboard and panels. The method of tagging shall be with the adhesive type of marker equal to 'Brady'. The tag shall indicate both panel and circuit number. Each conductor shall be color coded throughout the system. Markers shall be applied after wire is installed in conduit. All junction boxes above accessible ceilings shall be marked with the panel and circuit numbers of the wires contained inside. Where multiple neutral conductors are allowed and installed in a common raceway or enclosure, they shall not be intermixed. To avoid possible combination of neutral provide Brady adhesive style markers with circuit number or tracer color strip on insulation.

I. AC and MC cable shall be permitted for concealed branch circuits located where concealed from view in suspended ceiling systems, framed construction, attic spaces, soffits and catwalks. Other uses include: motor connections, fire/smoke damper connections, lighting fixture drops and manufactured flexible wiring systems for light fixtures. All other uses for MC or AC cable must be approved by the Engineer. MC or AC cable shall not be used for branch circuit wiring located in masonry walls, below grade, in concrete pours or the portion of the circuit home run from the flush panel to the accessible ceiling above the room served.

J. Branch circuit home runs shall be single conductors installed in raceway from the panel to a ceiling mounted junction box located in the first room served. At the contractor's option MC or AC cable may be used from this junction to circuit completion. AC or MC cable from the home run junction box to the circuit end maybe run daisy chained. Home runs installed below grade shall be run with single conductors in non-metallic conduit below floor and EMT conduit above. Home runs installed below grade shall rise to the accessible ceiling space before converting to AC or MC cable. The junction box shall be sized to add at least two additional MC or AC cables for future expansion.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
    1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150mm) of slack.

3.5 BRANCH CIRCUIT AND FEEDER WIRING INSTALLATION

A. Accompanying drawings indicate general direction of routes of branch-circuit home runs and the equipment assigned to each circuit. No deviations are permitted without the Engineer's approval.

B. The drawings are schematic only and do not indicate branch circuit wire counts. It is the Contractor's responsibility to determine the quantity of wiring required to provide the switching, control and power feeds necessary for the circuit requirements indicated. Power distribution and equipment feeders are indicated on the One-Line diagrams and/or the equipment schedules on the drawings.

C. No more than four branch circuits in any home run unless specifically indicated on the drawings. When more than three current carrying conductors are installed in a single raceway, wire and/or conduit size shall be increased to comply with Article 310.16 of the NEC.

D. Neutrals: Each single phase, 120V or 277V branch circuit and all feeders requiring a neutral, shall be provided with a dedicated (neutral) conductor. Neutrals shall not be shared between multiple circuits.

E. Where motor rotation dictates that two conductors be swapped, such swap shall occur at the motor end not the panelboard end or on the load side of any disconnecting device servicing said motor.

F. Each branch circuit phase conductor serving lighting circuits with electronic dimmers shall be provided with a dedicated neutral conductor and such neutral conductors shall not be intermixed.

G. Neatly train wire inside boxes, equipment, contactors, panelboard and other such electrical equipment. Do not bundle conductors with tie-wraps, etc.

H. Conductor length for parallel feeders shall be identical.

I. Conductors shall be suitably protected against painting or other substances throughout the entire installation process. It shall be the Division 26 Contractor's responsibility to assure that the insulation is in no way susceptible to substances such as paint or plaster. All device openings shall be protected with masking tape, plastic or similar protection and this protection maintained until device installation time.

J. Connections to devices or equipment served by a common circuit shall be pigtail connected. Pigtails shall be limited to the minimum number of conductors required to place the device or equipment into service.

3.6 VOLTAGE DROP

A. Wiring Sizes indicated are based on estimated routing. The Contractor is to determine the actual routing required in the field and shall adjust conductor and conduit sizes as required to compensate for voltage drop.

B. Feeders and branch circuits shall be adjusted in conductor size to compensate for voltage drop. It is the Contractor's responsibility to ensure that the wiring is sized properly for the load with a maximum voltage drop of 3% at the end of the circuit. Under-voltage problems created by the failure of the contractor to size wiring for voltage drop shall be corrected at the Contractor's expense.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Test all conductors and connections for continuity and grounds prior to energizing the circuit or feeder.
   2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for opens, shorts, phase polarity and compliance with requirements of this specification.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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

END OF SECTION 26 05 19

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.
   1. Main service grounding electrodes
   2. Equipment ground
   3. Enclosure bonding
   4. Raceway bonding

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Ground rods
   2. Ground bus bars
   3. Exothermic welding
   4. Compression fittings

1.4 QUALITY ASSURANCE

A. Retain first paragraph and subparagraph below if Contractor selects testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with UL 467 for grounding and bonding materials and equipment.

D. IEEE Compliance: Comply with applicable requirements of IEEE# Standard 142 pertaining to electrical grounding.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless green jacket otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3
   2. Stranded Conductors: ASTM B 8
   3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
   4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   5. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions. CADWELD® or approved equal.

2.3 GROUNDING ELECTRODES

A. NFPA 70 allows alternative types of grounding electrodes including ground rods, ground rings, metal underground water pipes, metal building frames, Ufer grounds, and pipe and plate electrodes. Retain Part 3 "Applications" and "Installation" articles to specify where these items are required and coordinate with Drawings.

B. Ground Rods: Copper-clad steel, sectional type; 3/4-inch by10 feet (19 mm by 3 m) in diameter.

2.4 GROUNDING BUS

A. Service Entrance Communication Ground Bar:

B. Provide a single point ground connection copper busbar; ¼" x 4" in cross section, 12" length with five pair of 7/16" holes on 2" (horizontal) x 1" (vertical) spacing and two insulated mounting stand-off brackets. Basis of Design: Erico #EGBA14412BB.

C. Telecommunications Room Ground Bars:
   1. Provide surface mounted Telecommunications grounding busbars in each Telecommunication room or cabinet, for bonding to the main electrical service grounding electrode and to provide telecommunication room equipment bonding. Provide complete installation of electro-tin-plated copper busbar, insulators, brackets, and fasteners for low resistance corrosion free contact between the lugs and the busbar.
   2. Main Distribution Frame (MDF) room, Telecommunications Main Grounding Busbar (TMGB): ¼"x4"x15.5"; Basis of Design: Eritech (Erico) #TMGB-A16L19PT
   3. Intermediate Distribution Frame (IDF), Telecommunications Grounding Busbar (TGB): ¼"x2"x12"; Basis of Design: Eritech (Erico) #TGB-A12L06PT

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No.6 AWG and larger, unless otherwise indicated. Equipment ground conductors shall be green insulated, unless otherwise noted.

B. Underground Grounding Conductors: Install bare copper conductor, No. 3/0 AWG minimum. Bury at least 24 inches (600 mm) below grade.

C. Main Electrical Service Grounding Bus (MSGB): Install the MSGB in an accessible location to facilitate future connections. Utilize exothermic or mechanical connection methods of attachment for each grounding/bonding conductor.

D. Telecommunications Grounding Busbars (TGB): Install TGBs in accessible locations to facilitate future connections. Utilize exothermic or mechanical connection methods of attachment for each grounding/bonding conductor.

E. Locate the TGB in each telecommunication room or cabinet adjacent to the IT racks or cabinets. Bond to the main electrical service grounding electrode and to telecommunication room equipment.

F. Install in electrical and telecommunication equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.

2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
3. Bond to all telecommunications racks, cable trays metallic sweeps and other communications equipment.

G. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits. Conduit (raceway) systems are not an acceptable grounding method.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Install ground cables continuous between connections. Splices will not be allowed except where indicated on the drawings. Welded connections or approved compression methods are not considered splices.

D. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

E. The grounding electrode conductor shall be mechanically protected. Where ground cables pass through floor slabs, building walls, etc., and are not in metallic enclosures, provide sleeves of approved nonmetallic material.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least two rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
4. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

E. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

F. Metallic sweeps or end pieces which are part of a non-metallic raceway system shall be bonded per NEC.

G. The self-grounding feature of receptacles shall not be utilized. Provide a grounding conductor from the ground screw on the device to the circuit grounding conductor.

H. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.4 COMMUNICATION GROUNDING

A. Provide #3/0 AWG bare copper ground from the main service grounding electrode to the main communications Grounding Busbar. From the main communications busbar provide one No. 2 AWG bare cu. conductor to each communications equipment room grounding busbar. Provide one No. 6 AWG bare cu. conductor to the serving telephone company demarcation equipment. Provide one No. 6 AWG insulated cu. conductor to the fire alarm control panel.

B. Provide connections using compression fittings to the communications grounding busbars.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
b. Perform tests by fall-of-potential method according to IEEE 81.

B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

D. Provide written report of ground resistance measurements for inclusion in O&M Manual.

END OF SECTION 26 05 26

SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.
   2. Nonmetallic slotted support systems.

1.6 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide comparable product by one of the following manufacturers:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. Thomas & Betts Corporation.
      e. Unistrut; Tyco International, Ltd.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

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

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) MKT Fastening, LLC.
         4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      a. Manufacturers: Subject to compliance with requirements, provide comparable products by one of the following manufacturers:
         1) Cooper B-Line, Inc.; a division of Cooper Industries.
         2) Empire Tool and Manufacturing Co., Inc.
         3) Hilti Inc.
         4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         5) MKT Fastening, LLC.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

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

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

2.3 CONCRETE HOUSEKEEPING PADS

A. Concrete shall meet the requirements of Division 03, ‘Cast-in-Place Concrete’.

B. Concrete housekeeping pads; 4-inch (100-mm) minimum nominal thickness.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   9. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.

10. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps.
11. To Light Steel: Sheet metal screws.
12. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

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

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

3.4 CONCRETE BASES

A. Concrete pole bases may be pre-cast or field constructed in accordance with the drawing details.

B. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

C. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Anchor equipment to concrete base.
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Division 09 painting sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION

SECTION 26 0533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. 26 0519, Low Voltage Electrical Power Conductors and Cables

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. LFNC: Liquidtight flexible nonmetallic conduit.

H. NBR: Acrylonitrile-butadiene rubber.

I. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide comparable products by one of the following manufacturers:
   1. AFC Cable Systems, Inc.
   2. Alflex Inc.
   3. Allied Tube & Conduit; a Tyco International Ltd. Co.
   4. Anamet Electrical, Inc.; Anaconda Metal Hose.
   5. Electri-Flex Co.
   6. Manhattan/CDT/Cole-Flex.
   7. Maverick Tube Corporation.
   8. O-Z Gedney; a unit of General Signal.

9. Wheatland Tube Company.

B. GRS: Galvanized Rigid Steel Conduit: ANSI C80.1.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. EMT: ANSI C80.3.

F. FMC: Zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
   2. Fittings for EMT: Steel, set-screw or compression type.
   3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

I. Sweeps and bends for 1-1/4” and larger shall be manufactured.

J. Sweeps and bends for limited energy systems shall be as follows:
   1. Less than 2”C – bend radius shall be a minimum of six times the internal conduit diameter.
   2. 2” or greater – bend radius shall be a minimum of ten times the internal conduit diameter.

K. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

L. Expansion/Deflection Couplings: rated for indoor/outdoor, underground, concrete embedded non-hazardous locations. UL standard 514B. The coupling shall accommodate the following movements without collapsing or fracturing conduit.
   1. Axial expansion or contraction up to ¾”
   2. Angular misalignment of axes of the coupled conduit runs in any direction to 30º.
   3. Parallel misalignment of axes of coupled conduit runs in any direction to ¾”
   4. Inner sleeve maintains constant inside diameter in any position
   5. Watertight flexible neoprene jacket
   6. Corrosion resistant
   7. Tinned copper flexible braid ground straps
   8. Stainless steel jacket clamps
   9. Standard tapered threads

2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide comparable products by one of the following manufacturers:
   AFC Cable Systems, Inc.
   Anamet Electrical, Inc.; Anaconda Metal Hose.
   Arnco Corporation.
   CANTEX Inc.
   CertainTeed Corp.; Pipe & Plastics Group.
   Condux International, Inc.
   ElecSYS, Inc.
   Electri-Flex Co.
   Carlon Electrical Products.
   Manhattan/CDT/Cole-Flex.
   RACO; a Hubbell Company.
   Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

D. LFNC: UL 1660

E. Fittings for LFNC: UL 514B.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide comparable products by one of the following manufacturers:
   1. Arnco Corporation.
   2. Endot Industries Inc.
   3. IPEX Inc.
   4. Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible type, approved for plenum, riser, or general-use installation.

2.4 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide comparable products by one of the following manufacturers:
   1. Cooper B-Line, Inc.
   2. Hoffman.
   3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, or 3R, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type, Screw-cover type, Flanged-and-gasketed type or as indicated.

E. Finish: Manufacturer's standard enamel finish.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide comparative products by one of the following manufacturers:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. EGS/Appleton Electric.
   3. Erickson Electrical Equipment Company.
   4. Hoffman.
   5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
   6. O-Z/Gedney; a unit of General Signal.
   7. RACO; a Hubbell Company.
   8. Robroy Industries, Inc.; Enclosure Division.
   9. Scott Fetzer Co.; Adalet Division.
   10. Spring City Electrical Manufacturing Company.
   11. Thomas & Betts Corporation.
   12. Walker Systems, Inc.; Wiremold Company (The).
   13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

D. Outlet boxes for flush mount, 2-1/8” deep (minimum), 4” square with ganged ring, 14 gauge galvanized pressed steel, with return flange and screw retained cover, standard outlet box with stamped knockouts. Lighting fixture boxes same except round.

E. Boxes installed in concrete block masonry shall be equipped with a 1-1/2” square cornered tile extensions.

F. Pull and junction boxes 100 cubic inches or smaller: standard outlet box with stamped knockouts.

G. Pull and junction boxes 150 cubic inches or larger: code gauge steel with sides formed and welded, with screw covers unless indicated to be provided with hinged doors. Hinged cabinets shall be lockable with key set to match the panelboards unless noted otherwise.

H. Non-recessed exterior device boxes shall be Die Cast Aluminum, 2-5/8” deep, single gang, with (3) 1” threaded outlets, rated for NEMA 3R applications. Basis of design: Raco 5387-0.

I. Exterior wet location covers shall be low profile single or two gang, NEMA 3R, UL rated for “extra duty”, in-use and compliant with NEC article 406. Covers shall be mountable to flush rough-in boxes and accept full size padlocks. Equal to Taymac #MX4280S (single gang) and MX7280S (double gang).

J. Die Cast Aluminum Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum or galvanized, cast iron with gasketed cover.

K. Prohibited materials: Sectional boxes, “handy boxes” and non-metallic boxes indoor.

L. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

M. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum galvanized, cast iron with gasketed cover.

N. Audio/Visual control & input device boxes for flush mount, 2.875” deep (minimum), 5” square with two ganged ring, 14 gauge galvanized pressed steel, with return flange, screw retained cover and stamped knockouts; (1) ½” & (2) 1” per side & (3) ½” & (2) ¾” on back. Equal to Randl Industries, Inc. #R-55014 box with #L-52G034 extension ring.

O. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures: Plastic

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.
   1. Configuration: Units shall be designed for flush burial and have open or closed bottom, unless otherwise indicated.
   2. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   3. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   4. Cover Legend: Molded lettering, "ELECTRIC","TELEPHONE", “FIBER” or as applicable for each service.
   5. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   6. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Minimum Dimensions: Unless otherwise noted or required by the NEC for the quantity and size of conductors in each box, provide handholes or boxes no less than the dimensions listed below for each type of service.
   1. Line voltage wiring – 12” (305 mm) depth, 15” (380 mm) width at base, 22” (560 mm) length at base.
   2. Limited Energy (50V or less) wiring – 12” (305 mm) depth, 15” (380 mm) width at base, 22” (560 mm) length at base.
   3. Fiber optic cable – 24” (609 mm) depth, 25” (635 mm) width at base, 25” (635 mm) length at base.
   4. Power, telephone, CATV or fiber optic utility wiring or cable – as required by the serving utility.

C. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two. Rated load 15,000 lb minimum.
   1. Manufacturers: Subject to compliance with requirements, provide comparable products by one of the following manufacturers:
      a. Armorcast Products Company.
      b. Carson Industries LLC.
      c. NewBasis.
      d. Utility Vault
      e. Quazite

2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Tests of materials shall be performed by an independent testing agency.
   2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

2.8 SAND BEDDING

A. Imported sand bedding is required for all electrical and low voltage system trenches.

2.9 EXTRA MATERIALS

A. Provide the extra materials described in subparagraphs below that match products as defined by the drawings and this specification. This material shall be installed as directed during construction. The contractor shall consider a difficult installation that may require ceiling tiles to be removed/replaced, finished walls being cut to install boxes used and walls to be ‘fished’ with MC cable or flexible conduit to install the devices where directed. It shall be assumed that this work will occur below 12’-0” AFF.

B. Extra materials that are not installed during construction shall be turned over to the owner at the end of construction (closeout). Products that are not installed shall be packaged in their original containers with protective covering for storage and identified with labels describing contents.

C. The contractor shall include the following in their bid:
   (30) single gang cut-in (remodel) boxes.
   (600’) Flexible steel conduit, ½”.
   (60) Flexible steel box connectors
   (120) Flexible steel conduit straps
   (20) 1” EMT sleeves, 12” long with nylon throated fittings and plastic bushings on each end
   (40) 1” EMT straps
   (10) 2” EMT sleeves, 12” long with nylon throated fittings and plastic bushings on each end
   (20) 2” EMT straps
   Fire caulking for (2) 1” and (10) 2” sleeves
   Labor to install extra materials

D. The extra sleeves are intended to be used for LV telecommunications cable.

E. Submit a fair cost value for these devices along with material submittals, on the form following this specification section. This fair cost estimate shall include all direct job expenses such as equipment rental, small tool expense, layout and supervision, etc. for a complete installation as if the material were shown on the drawings and taken off for bid. Breakout material and labor costs for each extra

material indicated. Unused labor will be credited back to the owner. At the Architect or Engineer's option this fair cost value may be applied to other work not included in the bid documents.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed Conduit: Rigid steel conduit, IMC or RNC.
   2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC or EMT.
   3. Underground Conduit: RNC, Type EPC-40 or 80-PVC, direct buried.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R or 4.
   6. Application of Handholes and Boxes for Underground Wiring:
      a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete or Fiberglass enclosures with polymer-concrete frame and cover, SCTE 77, Tier 15 structural load rating.
      b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Polymer-concrete units or Heavy-duty fiberglass units with polymer-concrete frame and cover, SCTE 77, Tier 8 structural load rating.
      c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

B. Indoors: Comply with the following indoor applications, unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT or IMC.
   2. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   3. Final Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations. Maximum length 72".
   4. Extended Damp or Wet Locations: Rigid steel conduit or IMC.
   5. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway or EMT.
   6. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway or EMT.
   7. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
   8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 1/2-inch (16-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Retain first paragraph below for high-frequency installation.

G. Aluminum conduit is prohibited.

3.2 INSTALLATION OF CONDUITS AND RACEWAYS

A. General: A conduit system shall be provided for all electrical systems wiring excluding low voltage (limited energy) systems where located above suspended acoustical tile ceilings, and where the cable installed is rated for the environment (riser or plenum).

B. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

C. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

D. Complete raceway installation before starting conductor installation.

E. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

F. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

G. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

H. Conceal conduit within finished walls, ceilings, and floors, unless otherwise indicated.

I. First paragraph below is more restrictive than NFPA 70, which permits up to four quarter bends in a conduit run. Retain below for more conservative design, with less stress being placed on wire being pulled in.

J. Conceal conduit within new finished walls, ceilings and floors or where existing structure is exposed to allow concealment of conduit.

K. Surface conduits and raceways are to be neatly installed only where concealment is not possible or in unoccupied areas, mechanical rooms, electrical rooms, or other utility areas. The Contractor shall demonstrate to the Architect that conduits cannot be concealed prior to installing surface conduit in occupied areas. All surface conduits are to be installed prior to painting and painted to match room finish. All raceway or conduits in on-concealed applications shall be installed parallel and perpendicular with or at right angles to the building lines and not diagonally to them.

L. Surface conduit and raceway shall be installed level (horizontal or vertical) unless following angular structural or architectural elements.

M. Route exposed conduit to be as concealed from view as possible by using structural or architectural elements to block the view.

N. All rigid conduit shall be reamed after threads are cut not before. All joints in conduit shall be cut square and shall butt solidly into couplings. Running threads will not be permitted.

O. Raceways Embedded in Slabs:
   1. 2” minimum concrete cover is required.
   2. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   3. Arrange raceways to cross building expansion joints at right angles with expansion/deflection fittings.
   4. Change from RNC, Type EPC-40-PVC, to rigid steel conduit or IMC sweeps before rising above the floor.
   5. Conduits stubbed up through floors for connections to free standing equipment shall be provided with a coupling set flush with the finished floor. When not activated the coupling shall be sealed with a deck plug.

P. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

Q. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Identify each end to indicate destination.

S. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where otherwise required by NFPA 70.

T. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).
   1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
      a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
      b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
      c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
   2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.
   3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

U. Flexible Conduit Connections: FMC shall not be used as a predominant type of raceway for branch circuit wiring. Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

V. All conduits located in masonry walls shall be located in the hollow core of these walls. All conduits above floor slab are to be metallic. Conduit in block walls cannot be PVC unless it is encased in concrete (2” minimum) or approved by the Authority Having Jurisdiction.

W. The maximum quantity of conduit in any CMU block cell is two for conduits smaller than 1”C.

X. Conduit installed above suspended ceiling systems shall not obstruct the removal and installation of tiles or access to equ8pment located in such space.

Y. All conduit serving roof mounted equipment shall be installed horizontally below the roof. Only vertical penetrations to devices or disconnects shall be allowed above the roof. Exception: Exposed conduit may run horizontally on the parapet wall where it is not visible from grade, balconies or windows. Coordinate the installation of conduit attached below roof deck with the roofing installer. Conduits and conductors damaged by roofing screws shall be replaced at no extra expense to the Owner.

Z. Conduit systems run horizontally on the roof shall be supported from freestanding piers (as specified under Products). Support piers shall be provided a minimum of 10’-0” o.c. All conduit installed horizontally on the roof shall be galvanized rigid steel with a minimum size of ¾”. Exposed conduit runs are only acceptable on flat roofs where the run is concealed from ground level view. Roof conduits shall be galvanized rigid steel or EMT with watertight fittings.

AA. See 26 0519 for MC cable use.

3.3 INSTALLATION OF CONDUIT FOR LIMITED ENERGY WIRING

A. The requirements for the installation of conduit for limited energy systems are in addition to the other requirements specified in this section.

B. Run conduits for telecommunications cabling in the most direct route possible, parallel to building lines with no more than two 90º bends between pull points or pull boxes.

C. Pull boxes shall be sized wide and deep enough for pulling with a length of at least 12 times the diameter of the largest conduit.

D. Pull boxes shall be readily accessible and provided with identification on the cover, box interior and on the conduits entering and exiting the box. Conduit ID for exterior in ground pull boxes is not required.

E. Conduits intended for limited energy systems shall not include any condulet bodies (i.e. LBs) unless they are UL listed for communications cabling.

F. Communications conduit runs shall be bonded on one or both ends in accordance with the NEC and ANSI J-STD-607-A.

G. Conduit runs shall not exceed 100’ without a pull box unless otherwise indicated.

H. Where possible limit the overall conduit length to 150’ total.

I. Conduits shall be sized for the wire fill as recommended in ANSI/TIA/EIA-569-B, unless otherwise specified.

J. All conduit bends shall be long radius.

K. Raceways for Optical Fiber and Communications Cable: Unless otherwise noted, install raceways, metallic and nonmetallic, rigid and flexible, as follows:
   1. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
   2. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

L. The use of flexible conduit is not allowed for limited energy wiring unless specifically indicated.

M. Limited Energy system conduits shall not be run through the following spaces unless serving a device specified within that area:
   1. On top of cellular floors
   2. Flammable material storage areas
   3. Above boilers, incinerators, steam lines or other heat dissipating equipment.

3.4 OUTLET BOX APPLICATION

A. Interior Flush Boxes: Steel knockout type.

B. Interior Boxes Below Ceiling Spaces in Areas Other Than Electrical or Mechanical Rooms: Cast metal Type FB or aluminum Type FD.

C. Interior Boxes Above Accessible Ceilings, in Attics, Electrical, Mechanical or Other Utility Spaces Accessible Only to Authorized Maintenance Personnel: Steel knockout type.

D. Exterior Exposed Boxes: NEMA 3R or 4, Type FB or FS with gasketed cover.

3.5 INSTALLATION OF OUTLET BOXES

A. Each device, outlet or junction shall be provided with a galvanized or sherardized pressed steel box. Minimum of 4” square for flush wiring devices with a single or multi-gang plaster ring as required. Box depth shall be as required for the device to be installed.

B. All boxes shall be set level and located to meet accessibility requirements. Boxes determined by the Owner, Architect or Engineer to be inaccessible for service or which interfere with adjacent equipment accessibility, shall be relocated at no extra expense to the Owner.

C. Junction, outlet and pull boxes shall be installed as shown, or as necessary to facilitate pulling of wire and to limit the number of bends to code requirements. Boxes shall be permanently accessible.

D. Any boxes added for the benefit of the Contractor or to meet NEC requirements shall be provided at no additional cost to the Owner.

E. Reference architectural plans, details and specifications for finish wall materials. Provide extension rings as required for acoustical, tackable surfaces, etc.

F. Where devices are shown back-to-back on opposite sides of a wall they shall be installed offset. If the wall is fire rated, then the minimum shall be at least 24” apart with a stud in between.

G. Where multi-gang devices are indicated on the same side of a fire rated wall, provide multiple two-gang boxes as required for the quantity of devices. Devices may be stacked provided the maximum height for switches is not greater than +44” and the minimum height for receptacles and systems outlets is not less than +16” AFF. Provide 4” minimum separation between boxes.

H. Where power and systems devices are shown in the same proximity, locate the devices adjacent to each other at the same mounting heights.

I. Prior to rough-in, devices at counters, cabinets, millwork and casework are to be coordinated with shop drawings and architectural elevations/details. Where knee spaces are provided locate devices below counter. Where devices are shown in locations covered by casework, fixed shelving, etc., confirm intent prior to rough-in.

J. Surface boxes shall be sized to be flush with the outside dimension of the device plates installed. Boxes installed with overhanging device plates shall be replaced at no extra expense to the Owner.

K. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall.

3.6 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. The minimum burial depth for utility conduits shall be 36” below finish grade unless otherwise noted.
   2. The minimum burial depth for branch circuit wiring and communications conduits shall be 24” below finish grade unless otherwise noted.
   3. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
   4. Install backfill as specified in Division 31 Section "Earth Moving."
   5. Install a minimum of 3” sand bedding.
   6. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
   7. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
   8. Install manufactured rigid steel conduit elbows for stub-ups at building entrances through the floor and equipment mounted on concrete slabs.
   9. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
   10. Warning Tape: Bury red or orange warning tape approximately 18 inches (450 mm) above direct-buried conduits for duct banks or direct buried conduit runs in excess of 16” provide multiple warning tape 16” o.c. for entire length.

3.7 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a minimum of 6” level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Place cover on the enclosure before backfilling uniformly on all four sides. Backfill to grade level. Compact every six inches to ensure well compacted backfill.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.8 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and specification section 26 0573 Overcurrent Protective Device Coordination Study.

1.2 SUMMARY

A. Section Includes:
   1. Identification for conductors.
   2. Underground-line warning tape.
   3. Warning labels and signs.
   4. Instruction signs.
   5. Equipment identification labels.
   6. Miscellaneous identification products.
   7. Device plate identification.
   8. Flash protection markings.
   9. Labels to indicate equipment location above suspended ceilings.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70E-2004, Standard for Electrical Safety in the Workplace

B. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

C. ANSI Z535.4-1998, Product Safety Signs and Labels.

D. All material and equipment supplied under this contract shall be identified with an Underwriters Laboratories, Inc. (UL) label.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

F. Comply with WAC 296.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

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

C. Coordinate installation of identifying devices with location of access panels and doors.

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

PART 2 - PRODUCTS

2.1 SELF ADHESIVE LABELS

A. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
   1. Comply with ANSI Z535.1 through ANSI Z535.5.
   2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,
   3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE

2.4 IDENTIFICATION TAGS AND LABELS FOR ELECTRICAL EQUIPMENT

A. Equipment Identification Tags: Two-ply phenolic plastic (bake-lite), 1/16 inch thick, white with black 3/8 inch high engraved lettering, beveled edges, double stick tape. See 3.02 L.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. White tape with black lettering for normal systems, red for emergency.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.5 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Warning label and sign shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
   3. Flash protection markings as required by NEC.

2.6 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
   1. Engraved legend with black letters on white face.
   2. Punched or drilled for mechanical fasteners.
   3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.7 DEVICE PLATE LABELS AND IDENTIFICATION

A. Engraved stainless-steel Type 302, ¼ inch high lettering filled with enamel paint. Black for normal systems, red for emergency systems.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be ¼ inch clear tape with black lettering for normal systems, red for emergency systems. Brady ID PAL, ¾" printer/labeler or equal.

C. Accessible Junction and Pull Boxes Within Buildings: Identify the covers of each junction and pull box with self-adhesive vinyl labels with the wiring system, system voltage and circuit number within. Boxes located in accessible ceilings shall have permanent marker pen on outside cover plate, approximately ½ inch high letters, black for normal systems, red for emergency.

D. Receptacles: Identify panelboard and circuit number from which served. Use self-adhesive labeling machine, clear tape with 12 Pt black lettering on face of plate.

2.8 LOCATION INDICATION LABELS ABOVE SUSPENDED CEILINGS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Clear tape with black lettering for normal systems, red for emergency.

B. Install label to the bottom (room side) of the suspended ceiling 'T' directly below equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Provide identification as required by NEC (NFPA 70) and WAC 296 to indicate series ratings, flash protection, disconnecting means, or other information required by Code.

G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

H. Provide engraved, phenolic identification plates for switchboards, switchboard circuit breakers, panelboards, disconnect switches which identify the circuit source (panelboard and circuit number) that supplies the disconnect, per NEC and WAC requirements.

I. Equipment Identification, Emergency Systems: All boxes and enclosures, for Article 700 NEC systems larger than six inches by six inches, including transfer switches, generators, and power panels for emergency systems and circuits must be permanently identified with an identification plate that is substantially orange in color. All other device and junction boxes for emergency systems and circuits must be substantially orange in color, both inside and outside.

J. Identify all wiring by type or circuit number located with-in the box on the outside cover using a self-adhesive film equal to Brady ID PAL, ¾".

3.2 IDENTIFICATION

A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
   1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
   2. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.
   3. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
   4. Colors for 480/277-V Circuits:
      a. Phase A: Brown.
      b. Phase B: Orange.
      c. Phase C: Yellow.
   5. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

B. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Limit use of underground-line warning tape to direct-buried cables.
   2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

C. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive warning labels or Baked-enamel signs.
   1. Comply with 29 CFR 1910.145.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.

D. Panelboards: Mount inside door, on dead front, above circuit breakers, unless panelboard is located in a utility-type room, then install nameplate on outside of panelboard above door.

E. Disconnect switches: Mount nameplate on outside of cabinet, near top. Omit nameplate from disconnect switches if located adjacent to equipment.

F. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams and schedules.
   1. Labeling Instructions:
      a. Indoor Equipment: Engraved phenolic plastic tags self-adhesive. Unless otherwise indicated, provide a single line of text with 3/8-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
      b. Outdoor Equipment: Engraved phenolic plastic tags self-adhesive and mechanically attached with No. 4 chrome round head screws.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
      d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
      e. Mount tags top and centered on outside of covers and doors.
      f. Where panels are located in student occupied locations, put ID tags on the inside cover of the panel door.
   2. Equipment to Be Labeled:
      a. Panelboards:
         1) Typewritten directory of circuits in the location provided by panelboard manufacturer.
      b. Enclosures and electrical cabinets.

c. Access doors and panels for concealed electrical items.
d. Switchboards.
e. Distribution circuit breakers.
f. Transformers:
    1) Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
g. Enclosed switches, 200A and above
h. Enclosed circuit breakers, 200A and above
i. Power transfer switches.
j. Junction boxes.
k. Cabinets.
l. Pull boxes.

G. Flash protection: Field install arc-flash protection requirement labels.

H. Equipment Function Labels: On each electrical component associated with the control or disconnecting means of a piece of equipment, install unique designation labels consistent with wiring diagrams, schedules and operation and maintenance of the equipment serviced.
1. Labeling Instructions:
    a. Indoor Equipment: Adhesive film label
    b. Outdoor Equipment: Adhesive film label with clear protective overlay
2. Equipment to be labeled:
    a. Enclosed circuit breakers, 100A or less
    b. Safety switches, 100A or less
    c. Enclosed controllers.
    d. Variable-speed controllers.
    e. Push-button stations.
    f. Contactors.
    g. Remote-controlled switches, manual starters, timer switches, dimmer modules, and control devices.
    h. Battery-inverter units.
    i. Battery racks.
    j. Monitoring and control equipment.

I. Provide engraved metal plates at all switches installed for control of fans, pumps, remotely located lighting, illuminated signs, switched receptacles, contactors or other applications noted on the drawings.

J. Equipment location above suspended ceilings shall be identified with black 18 Pt. bold, lettering on clear background adhesive film labels applied to the ceiling Tee:
1. Relay or lighting control modules.
    a. Examples:
        1) RELAY ABOVE
        2) LCM ABOVE
        3) LC BRIDGE ABOVE

END OF SECTION 26 05 53

SECTION 26 0573 - SHORT CIRCUIT DEVICE COORDINATION & ARC FLASH STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the following Division 26 specification sections:
   1. 26 0553 Identification for electrical Systems
   2. 26 2200 LV Transformers
   3. 26 2413 Switchboards
   4. 26 2416 Panelboards

1.2 SUMMARY

A. This Section includes computer-based, fault-current, overcurrent protective device selective coordination and arc flash protection studies.

B. Protective devices shall be set based on results of the protective device coordination study.

C. The results of the Arc Flash Hazard study shall determine the Flash Protection markings required for each switchboard and panelboard on the power distribution system to meet the requirement of NFPA 70E and WAC.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Coordinate first paragraph below with qualification requirements retained in "Quality Assurance" Article.

E. Preliminary Study Report: Submit preliminary copies of the study prior to releasing electrical distribution equipment for manufacturer. The studies must be sufficiently complete to ensure that the selected devices have ratings and characteristics that will be satisfactory to provide selective coordination.

F. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in written and digital form.
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Study and Equipment Evaluation Reports.
   3. Coordination-Study Report.
   4. Recommended circuit breaker & relay settings.
   5. Arc Flash calculations and equipment label information.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

1.5 INFORMATION FOR O&M MANUAL

A. Final Study Report: Include final copies of the completed power system study, taking into account modifications to the distribution system undertaken as a result of the preliminary studies.

1.6 REGULATORY REQUIREMENTS

A. Utility Company Approval: Copies of the preliminary study report shall be submitted to the Electric Power Utility Company for their review and approval. An approval letter from the Utility Company shall be included with the preliminary study report submitted to the Engineer for review.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

D. The report shall also include the following sections:
1. Project description, purpose, basis and scope of the study
2. Fault current calculations
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties, and commentary regarding the same.
4. Copies of manufacturer’s time-current curves for the devices studies.
5. Protective device time versus current coordination curves.
6. Tabulations of relay and circuit breaker trip settings, fuse selections, and commentary regarding the same.
7. Arcing faults and Arc-Flash requirements for each switchboard and panelboard on the power distribution system.
8. Optional Features:
   a. Simultaneous faults.
   b. Explicit negative sequence.
   c. Mutual coupling in zero sequence.

E. A preliminary copy of the study report shall be submitted for review. The final report shall include such additions or changes as required by the reviewer.

F. The results of the power system studies shall be summarized in a bound study report. Multiple copies of the final report shall be furnished and included in the O&M Manuals.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
   1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:
   1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
   3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
      a. Circuit-breaker and fuse-current ratings and types.
      b. Relays and associated power and current transformer ratings and ratios.
      c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
      d. Generator kilovolt amperes, size, voltage, and source impedance.
      e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
      f. Busway ampacity and impedance.
      g. Motor horsepower and code letter designation according to NEMA MG 1.
         1) Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
      h. Special load considerations, including starting inrush currents and frequent starting and stopping.
      i. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
      j. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
      k. Generator thermal-damage curve.
      l. Ratings, types, and settings of utility company's overcurrent protective devices.
      m. Special overcurrent protective device settings or types stipulated by utility company.
      n. Time-current-characteristic curves of devices indicated to be coordinated.
      o. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
      p. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
      q. Panelboards, switchboards, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
   1. Switchboard.
   2. Distribution panelboard.
   3. Branch circuit panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, IEEE 241 and IEEE 242.
   1. Transformers:
      a. ANSI C57.12.10.
      b. ANSI C57.12.22.
      c. ANSI C57.12.40.
      d. IEEE C57.12.00.
      e. IEEE C57.96.
         1) Medium-Voltage Circuit Breakers: IEEE C37.010.
         2) Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
         3) Low-Voltage Fuses: IEEE C37.46.

E. Study Report:
   1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:
   1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
   3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   4. Arc fault calculations.
   5. Flash protection requirements based on arc fault calculations.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
   1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
   2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
   3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 141, IEEE 241, IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:
   1. Device shall not operate in response to the following:
      a. Inrush current when first energized.
      b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
    1) Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
    1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
        a. Device tag.
        b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
        c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
        d. Fuse-current rating and type.
        e. Ground-fault relay-pickup and time-delay settings.
        f. Flash protection requirements.

G. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Include ground fault settings. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
    1. Device tag.
    2. Voltage and current ratio for curves.
    3. Three-phase and single-phase damage points for each transformer.
    4. No damage, melting, and clearing curves for fuses.
    5. Cable damage curves.
    6. Transformer inrush points.
    7. Maximum fault-current cutoff point.

H. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION 26 05 73

SECTION 26 0800 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The purpose of this section is to specify the Contractor's responsibilities relative to Division 26 and participation in the commissioning process. See Division 1, Section 01 9113, “General Commissioning Requirements,” for Contractor-related commissioning requirements.
   1. Organization of the commissioning program is primarily the responsibility of the Commissioning Authority. Execution of the program is primarily the responsibility of the Contractor with support from the Division 26 for:
      a. Testing and start-up of the electrical equipment.
      b. Completion and endorsement of pre-functional test checklists provided by the Commissioning Authority to assure that Division 26 equipment and systems are fully operational and ready for functional testing.
      c. Providing qualified personnel to assist the Commissioning Authority with functional testing to verify equipment/system performance.
      d. Providing equipment, materials, and labor necessary to correct deficiencies found during the commissioning process which fulfill contract and warranty requirements.
      e. Providing training for the systems specified in Division 26 with coordination of Owner by the Commissioning Authority.

B. Division 26 shall cooperate with the Commissioning Authority in the following manner:
   1. Allow sufficient time before final completion dates so that electrical testing, lighting control checkout, and functional testing can be accomplished.
   2. Provide labor and material to make corrections when required without undue delay.
   3. Put all electrical systems and equipment into full operation and continue the operation of the same during each working day of commissioning.

C. Related Sections
   1. Section 01 9113 – General Commissioning Requirements
   2. Division 22 – Plumbing
   3. Division 23 – Mechanical
   4. Division 26 – Electrical
   5. Division 28 – Systems
      a. 28 0010 GENERAL PROVISIONS FOR ELECTRONIC SAFETY AND SECURITY
      b. 28 3113 ACCESS CONTROL & INTRUSION ALARM SYSTEM
      c. 28 3173 DISTRIBUTED ANTENNA SYSTEM

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Standard certified test equipment for commissioning will be provided by the Commissioning Authority.

B. Proprietary test equipment required by the manufacturer shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist the Commissioning Authority in the commissioning process.

PART 3 - EXECUTION

3.1 WORK PRIOR TO COMMISSIONING

A. Specific pre-commissioning responsibilities of Division 26 are as follows:
   1. Normal start-up services required to bring each system into a fully operational state.
   2. Complete pre-functional test checklists for all equipment and systems to be commissioned
   3. Portions of mechanical equipment start-up requiring electrical connections and metering.

4. Factory start-up services for key equipment and systems specified in Division 26. The Division 26 Contractor shall coordinate this work with the manufacturer and the Commissioning Authority.
5. Demonstrate system readings as requested by the Commissioning Authority and adjust units to achieve specified operation.

3.2 PARTICIPATION IN COMMISSIONING

A. The Division 26 Contractor shall provide skilled technicians to start-up and debug all systems within the Division 26 work (particularly with lighting equipment). These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested by the Commissioning Authority and coordinated by the Contractor. Contractor will ensure the qualified technician(s) are available and present during the agreed upon schedules, and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.

B. The Commissioning Authority reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment, system, and/or sub-system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment, and an attitude/willingness to work with the Commissioning Authority to get the job done. A liaison or intermediary between the Commissioning Authority and qualified factory representatives does not constitute the availability of a qualified technician for purposes of this work.

C. Provide skilled technicians to manipulate the following equipment and systems to be commissioned for functional testing:
   1. Lighting control systems
   2. Day lighting control system

3.3 WORK TO RESOLVE DEFICIENCIES

A. Maladjustments, misapplied equipment, and/or deficient performance under varying loads will result in a system that does not meet Acceptable Performance. Correction of work will be completed under the direction of the Owner/Architect, with input from the Contractor, Equipment Supplier, and Commissioning Authority. Whereas, all members will have input and the opportunity to discuss, debate, and work out problems, the Architect/Engineer-of-Record will have final jurisdiction on the necessary work to be done to achieve performance and/or design intent.

3.4 ELECTRICAL SYSTEM TESTING

A. Electrical system testing as required in other sections of this specification shall be coordinated with the Commissioning Authority. The Commissioning Authority may witness testing performed by the Division 26 Contractor.

B. All testing documentation related to Division 26 equipment and systems, as specified in other sections of this specification, will be provided to the Commissioning Authority for use and review.

3.5 SEASONAL COMMISSIONING AND OCCUPANCY VARIATIONS

A. Seasonal commissioning pertains to testing under full-load conditions during peak heating and peak cooling seasons, as well as part-load conditions in the spring and fall. Initial commissioning will be done as soon as contract work is completed regardless of season. All equipment and systems will be tested and commissioned in a peak season to observe full-load performance. Heating equipment will be tested during winter design extremes. Cooling equipment will be tested during summer design extremes, with a fully occupied building. The Contractor will be responsible to participate in the initial and the alternate peak season test of the systems required demonstrating performance.

B. Subsequent commissioning may be required under conditions of minimum and/or maximum occupancy or use. All equipment and systems affected by occupancy variations will be tested and commissioned at the minimum, and at peak loads to observe system performance. The Contractor will be responsible to participate in the occupancy sensitive testing of systems to provide verification of adequate performance.

C. Daylighting testing must be done during peak daylight times (as close to the summer solstice as possible) to ensure proper lighting levels during peak daylight down to minimum daylight amounts.

3.6 TRAINING

A. The Division 26 Contractor will be required to participate in the training of the Owner's engineering and maintenance staff for each electrical system and the related components. Training may be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids, or in the field with the specific equipment. The type of training will be per the Owner's option.

END OF SECTION 26 08 00

SECTION 26 0923 - DISTRIBUTED LIGHTING CONTROL

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work specified in this section.

B. Related Sections:
   1. Section 01 9100 – Commissioning: Commissioning responsibilities
   2. Section 26 0100 – Electrical Requirements: Product substitution procedures
   3. Section 26 0553 – Identification for Electrical Systems: Identification requirements
   4. Section 26 0510 – Commissioning for Electrical Systems: Electrical commissioning procedure
   5. Section 27 1500 – Telecommunications

1.2 SUMMARY

A. Provide a Code Compliant Distributed Networked Lighting Control System for interior lighting as indicated on plans and outlined in this section. This project was designed and permitted under the Washington State Energy Code.

B. Exact configuration, wiring methods, and system topology may vary by manufacturer. The contractor proposing the substitution shall be responsible for all wiring and system components necessary to provide a complete system that functions as designed to meet the specified sequence of operation. The contractor shall be responsible for cost associated with any necessary re-design to the construction documents required for rough-in and installation. All substitutions are contingent on shop drawings, to be provided prior to system pre-installation meeting. Shop drawings shall include detailed information regarding manufacturer's recommendations for wiring methods, sensor placement, topology, and other system requirements.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

C. BAS: Building Automation System

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. Products supplied shall be from a manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of five years.

C. All components shall be UL Listed, offer a five-year warranty and meet all state and local applicable code requirements.

1.5 SUBMITTALS

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

B. Shop Drawings: Show installation details for occupancy and light-level sensors, digital controls, control modules (including receptacle control modules), bridge locations, 120VAC power locations, interconnection diagrams showing field-installed wiring and auxiliary HVAC contacts.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

E. Manufacturer shall substantiate conformance to this specification by supplying the necessary documents, performance data and wiring diagrams. Any deviations to this specification must be clearly stated by letter and submitted.

F. Submit a lighting plan clearly marked by manufacturer showing proper product, location and orientation of each sensor.

G. Submit any interconnection diagrams per major subsystem showing proper wiring.

H. Submit standard catalog literature which includes performance specifications indicating compliance to the specification.

1.6 INFORMATION FOR OPERATING & MAINTENANCE MANUALS

A. Submittals: Information submitted for review, up-dated to record any changes.

B. Operating Instructions: Supply a detailed narrative description of the operation of the lighting controls. Indicate application conditions, limitations of use, coverage patterns and adjustments. Include manufacturer's installation instructions.

C. Maintenance Instructions: List replacement parts, including source. Indicate recommended maintenance and testing procedures and intervals. List all individual system components that require periodic maintenance. Include a service directory with names and telephone numbers to obtain service.

D. Warrantee: Manufacturer's warranty certificate.

PART 2 - PRODUCTS

2.1 DISTRIBUTED SYSTEM OPERATION REQUIREMENTS

A. The lighting control system specified in this section shall provide a combination of time-based, sensor-based (both occupancy and daylight), and/or manual lighting control.

B. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed). Dimmable lighting that is not in a daylight zone shall be manually dimmed from the associated control station(s) in the room. Dimmable lighting in daylight zones shall be automatically dimmed, with manual override control as described in this specification section and the sequence of operation for the applicable room requirements.

C. Lighting controls shall be coordinated with the lighting fixtures and supplied with all necessary components to produce a fully functional system. Components may vary based on the lighting control approach of the relevant manufacturers. The lighting control manufacturer components may be provided integral to the lighting fixtures. Integral control components is optional and dependent upon the manufacturer. The contractor shall verify whether or not control components are integral or external and adjust their bid to include any extra associated work. See section 26 5100 – Lighting.

D. All system devices shall be individually addressable and shall be networked together via network control cable to enable digital communication. Contractor to verify cable type and wiring topology required by manufacturer.

E. Individual lighting zones shall be capable of being segmented into sufficient channels of occupancy, photocell, and switch functionality to comply with advanced configurations and sequences of operation. Daylight zones and switched zones may differ in some spaces. System shall be capable of automatically controlling dimmed daylight zones independently of switched zones.

F. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function or global functionality as necessary to meet all sequences of operation.

G. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week utilization of a space. Note operating modes should be utilized only in manners consistent with local energy codes.

H. Time of day capabilities must meet local code requirements or at a minimum a 10 hour backup, astronomic time function and Holiday function.

I. Devices located in different lighting zones shall be able to communicate occupancy, photocell, and switch information via the CAT5 network as required to alter time delays, disable/enable functions, remotely monitor activity, etc.

J. The system architecture shall facilitate remote operation via a computer connection.

K. Networked interior distributed lighting controls shall consist of lighting control modules, relays, and associated input devices that operate in default capacity even if network connectivity to the greater system is lost. (Note: control modules may be integrated into light fixture as an “intelligent” light fixture.)

L. Occupancy based controls shall consist of Passive Infrared or dual-technology occupancy sensors connected via network control cable in larger, multi-zone spaces such as classrooms. In small offices, occupancy-based controls shall include dual technology, single or multi-zone wall switch type occupancy sensors.
   1. Dual technology sensors shall consist of Passive Infrared as a primary technology and Microphonic or Ultrasonic as a secondary technology.
   2. Occupancy-based controls for interior lighting shall provide automatic shut-off control as indicated for manual-on or automatic-on lighting as designated by code or sequence of operation.
   3. Sensors covering 1 lighting zone with 1 lighting level shall be manual on, auto off. Where multiple lighting levels are indicated (bi-level control), sensors shall be auto on to 50%, manual on to 100%, auto off.
   4. Occupancy sensors shall provide complete and proper volumetric coverage of each room within the coverage limits of the devices provided, in accordance with the manufacturer’s published coverage limits. Unless otherwise indicated, the coverage pattern shall provide detection of desk activity (hand motion) for over 90% of the room area minimum, as required to accommodate all occupancy habits of single or multiple occupants at any location within each room.
   5. Where sensors are located in gymnasiums or are indicated to be protected by wire guards, provide wire guards that fit over the devices to be protected. Wire guards for wall-mounted sensors shall secure to the wall and shall not be attached to the sensor itself.
   6. Wall switch occupancy sensors shall include means for manual adjustment. Sensors shall have adjustable sensitivity and time-delay settings, which shall be adjusted in each room to suit the actual room conditions. The occupancy sensors shall be adjusted such that the presence of one occupant within sight of the sensor is sufficient to keep the controls from automatically shutting off the lighting, with sufficient time-delay to allow an occupant to conduct any normal functions that may be out of sight from the sensor. Sensors covering 1 lighting zone with 1 lighting level shall be manual on, auto off. Where multiple lighting levels are indicated (bi-level control), sensors shall be auto on to 50%, manual on to 100%, auto off. Normal air movement while the room is unoccupied shall not in itself cause the occupancy sensors to remain activated. Sensor/Switches shall be provided with a button for each designated zone of control (or light level with rooms requiring bi-level switching).
   7. Occupancy-based controls shall include auxiliary contacts for interface with the energy management or building automation system for HVAC system control, in accordance with the requirements of Section 23 0900. Refer to mechanical plans for required auxiliary contact requirements. Auxiliary contacts may be housed in a network control device, and not the occupancy sensor itself.

M. Daylight harvesting of lighting shall include networked control devices capable of controlling multiple zones, daylight sensors capable of controlling multiple zones integrated with occupancy sensor controls, and system switching/dimming devices capable of override as allowed by code.
   1. Day lighting zones shall be established for all general lighting in the indicated rooms as defined by the local energy code. The primary daylight zone shall extend horizontally from the vertical exterior glazing of the space a distance equal to the total head height of the glazing, and for the width of each window plus an additional 0.6 m (2 ft) on both sides of the window. The secondary daylight zone shall start at the border of the primary daylight zone and extend two times the head height of the vertical glazing. Each daylight zone, primary and secondary, shall have separate, independent sensors allowing for automatic control and override capability as indicated in the sequence of operation.
   2. Separate day lighting zones with separate controls shall be established for all lighting that is under skylights and lighting that is within a horizontal distance from the edge of the skylight of 70 percent of the room's ceiling-to- floor height. Refer to local energy code for additional information on the definition of daylight zones for horizontal glazing and skylights.
   3. Daylight sensors shall consider total amount of available lighting at any given time, from both natural and artificial sources and react to referenced sequences of operation.
   4. Daylight sensors shall provide separate adjustable set points and daylight harvesting shall be accomplished by either continuous dimming of fixtures in the daylit zone to less than 20 percent of the rated power at maximum light output OR stepped dimming with two control channels per zone; one step between 50 and 70 percent of design lighting power and another no greater than 35 percent. Stepped dimming systems shall also be capable of automatically turning the daylit zone off and shall incorporate time delays or dead-bands to prevent cycling of light levels of less than three minutes.
   5. Multi-level daylight-harvesting controls shall be compatible with occupancy sensors, which shall function as described above to shut off all lights in the room, including those in the day lighting zone, when the room is unoccupied. Occupancy sensors shall shut off the lights in the room regardless of whether the daylight harvesting controls are in the automatic or manual mode and regardless of the ambient illumination.
   6. Daylight harvesting controls shall be located according to manufacturer's instructions.
   7. In each room that is equipped with multi-level daylight-harvesting controls, a manual override switch shall be provided. When the manual override wall switch is activated, the controls shall hold the lighting at the user-designated level until the controls are returned to automatic control. Manual over ride shall switch back to automatic control after a 2 hour over ride period or after a cycle of occupancy.

N. Wall Control Stations (other than wall type, stand-alone occupancy sensor switches) shall be Class 2 devices networked with control cable and shall include on/off/dim or scene functions to initiate the proper sequence of operation for the space.

O. A networked UL 924 compliant emergency control device shall be used that monitors a switched circuit providing normal lighting to an area, and an un-switched normal circuit. The unit provides normal ON/OFF/Dim control of emergency lighting along with the normal lighting (ON/OFF control is monitored by the switched monitor circuit). Upon normal power failure (loss of power to un-switched circuit), the emergency lighting circuit will close, forcing the emergency lighting ON and FULL if dimmed until normal power is restored. Upon restoration of normal power, lighting shall function as specified in default mode, which includes dimming and daylight harvesting.

2.2 DISTRIBUTED SYSTEM CABLE

A. General: Wire size shall be minimum #12 AWG, except low-voltage control cable. Power and grounding conductors shall be minimum #12 AWG. Cable shall be rated CL2 where installed in conduit. Cable run open air shall be CL2P, plenum rated.

B. Network cable: to be provided per manufacturer's requirements. Network cable shall be white or green. All network cable to be installed in accordance with requirements in section 271500.

C. Low-Voltage Control Cable: #16 AWG, multi-conductor cable with jacket to match color of network cable, except as otherwise indicated. Quantity of conductors as required for connected devices. Dimming control cabling (0-10V) shall be installed in raceway (1/2" EMT), except where installed above an accessible ceiling. All cable in plenum spaces shall be plenum rated

2.3 LINE VOLTAGE WALL OCCUPANCY SENSORS

A. Wall Switch Occupancy Sensors: Decora style wiring device shall include "off" and "auto" controls, a dual technology, passive infrared/ultrasonic occupancy sensor and an indicator light that illuminates when the sensor detects occupancy.

B. The sensor shall have a high-density 180° coverage pattern that detects walking motion within 7.5 m (24 ft) in front of the device and 3.0m (10 ft) to either side when mounted 1.2 m (4 ft) above the floor. The device shall be arranged for manual control to switch lights on, and automatic control to switch lights off.

C. Sensors shall have adjustable sensitivity (minimum to maximum) and time delay (30 seconds to 30 minutes) settings. Sensors shall initially be set at maximum sensitivity and 15 minutes delay. The device shall be rated for control of up to 800 Watts of ballast load at 120 VAC or 1200 Watts of ballast load at 277 VAC and shall be compatible with LED drivers.

D. The device shall allow no leakage to load when in the "off" mode and shall have no minimum load requirement. Wall switch occupancy sensors shall be equivalent to the following based on type of control specified: Type DW: Manual ON, Automatic OFF Wall switch type dual technology, passive Infrared and ultrasonic occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; To be furnished by manufacturer of complete distributed lighting control system.

2.4 MANUFACTURERS

A. Basis of Design: The Distributed Lighting Control system components indicated on the Division 26 drawings and as specified in this section, are based on the products and wiring methods for an Acuity Brands (nLight) system. Other approved systems are listed in paragraph A above. The other approved systems listed may utilize different components, wiring methods and require additional line voltage power than what is indicated in the bid documents for the nLight system. It shall be the system provider/vendor's responsibility to indicate all additional cost and system differences which may add labor or materials in their bid proposal to the electrical contractor. The owner shall not consider nor approve any additional cost claimed by the contractor because the control system provided does not match what is shown on the bid documents.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acuity Brands (nLight)
   2. Intelligent Lighting Controls (ILC)
   3. Hubbell NX

C. Distributed System Cabling:
   1. Beldon
   2. Canare
   3. West Penn
   4. nLight
   5. Watt Stopper (The)

D. Line Voltage Wall Occupancy Sensors:
   1. Acuity Brands (Sensor Switch)
   2. Hubbell Control Solutions
   3. Legrand (Wattstopper)
   4. Leviton

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to beginning rough-in for the automatic lighting controls, The Electrical Contractor shall arrange a pre-installation meeting on the site between all parties involved in the automatic lighting control system installation, including the Electrical Systems Installer, the manufacturer's Factory Authorized Representative and the Owner's Representative. All parties shall review the automatic lighting control shop drawings, the manufacturer's installation instructions, applicable regulations and any site conditions pertinent to installation of the automatic lighting controls. Verify placement of sensors and installation criteria. This meeting should be in conjunction with pre-installation meeting required for Section 26 0943.

B. The Electrical Contractor shall prepare minutes of the pre-installation meeting and distribute them to all parties in attendance at the meeting, as well as the Owner's Representative and the Architect.

3.2 INSTALLATION

A. Install equipment in accordance with the manufacturer's instructions in the locations indicated on the Drawings. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. All Category cable shall be installed in accordance with Section 27 1500.

B. Coordinate the control requirements of all devices and sensors to insure proper operation. Provide all necessary accessories.

C. Locate interior photocells where they are protected from direct sunlight and where they can be aimed toward the zone they are controlling. Photocells to be installed per manufacturer's recommendations, and should be closed-loop, requiring multiple sensors for rooms with multiple daylight zones and zoning per day-lighting requirements. Photocells controlling non-dimmed zones shall consider natural and artificial light, but not be in direct sunlight, or directly under a lamp source.

D. Locate and aim occupancy sensors as required for complete and proper volumetric coverage within the range of coverage of controlled areas per the manufacturer's recommendations. Rooms shall have 90% minimum coverage to completely cover the controlled area. Coverage shall accommodate all occupancy habits of single or multiple occupants at any location within the room. The locations and quantities of sensors shown on the Drawings are diagrammatic and indicate only the minimum quantity and placement of sensors that are to be provided. Provide additional sensors if required to properly and completely cover the respective room. Locations shall be carefully selected to ensure that coverage patterns are unobstructed.

E. Contractor is to provide a sufficient quantity and layout of occupancy sensors to properly meet coverage and intended sequence of operation. Locations shall be carefully selected to ensure that coverage patterns are unobstructed.

F. Mount occupancy sensors and photocells in finished spaces according to manufacturer instructions. In unfinished spaces or where ceiling-type sensors are installed where there is exposed structure, mount the sensors in surface mounted outlet boxes.

G. Wiring shall be arranged as shown on the shop drawings. Wiring and cable shall be installed in raceways or cable trays, except low-voltage cables run above accessible ceilings consisting of removable tiles. Raceways shall be grounded to the power system ground.
   1. Network control cables shall connect control devices in uninterrupted continuous runs without intermediate splices. Cables shall be free from shorts or ground and shall be tested.
   2. Cables shall be routed so as to maintain a separation of at least 610 mm (24 in) from all heat sources and from ballasts, transformers, dimmers and other sources of electromagnetic interference. Avoid exposed cables in occupied areas or in areas where they might be

damaged as a result of normal use of the area. Where two (2) or more cables run in parallel, they shall be bundled with cable ties.

3. Cables run exposed in ceiling cavities shall be supported by means of suitable cable support devices from the building structure. They shall not lie upon the ceiling, nor shall they be supported from the ceiling frame, ceiling suspension wires, conduits, pipes, ductwork or lights. Supports shall be spaced no further apart than 5 ft on center.
4. Care shall be exercised during cable installation not to damage cable insulation. Damaged cables shall be removed and replaced. Type and spacing of supports shall ensure that cable will not kink or sag.
5. In each cable that terminates at a ceiling device, provide 305 mm (12 in) of slack cable, neatly coiled, to facilitate future modifications. Terminations shall be made in a neat and workmanlike manner, and in accordance with Section 271500.
6. Terminate the manufacturer's recommended cable type to the appropriate termination point (RJ45 jack, etc.).
7. Cabling for 0-10V dimming control shall be installed in raceway (1/2" EMT), except where installed above accessible ceiling. Cabling for 0-10v dimming control shall be Class 2 and separate from any line voltage wiring. Raceway shall be installed orthogonal to room surfaces and be concealed by structure wherever possible.
8. Networked control cable shall be run orthogonal to room surfaces, be routed along edges of rooms and concealed by structure wherever possible. Electrical Contractor to record and provide identification of control devices (Device ID #'s) in each space per manufacturer instructions. commissioning

3.3 SEQUENCE OF OPERATIONS

A. Typical Classrooms: All fixtures are controlled by manual digital controls, occupancy sensors & daylight sensors located within the room. The classrooms shall be configured to require manual on, vacancy off and automatic light level adjustment of the fixtures located within the designated daylight zones. The room shall be set up for two control zones. The row of light fixtures closest to the teaching (projector screen) wall shall be manually controlled separately from the remainder of the room lights. The digital controller shall provide manual on/off and dimming for each control zone. The occupancy sensors shall be programmed for vacancy off after a 15-minute time period. The daylight sensors shall dim the fixtures located within the daylight zones to maintain a minimum 30 FC light level from combined artificial and daylight on all horizontal and vertical teaching surfaces. Science, Art and vocational spaces require a minimum 50 FC. The lighting fixture row parallel to the teaching wall of the classroom shall be controlled separately from the remainder of the classroom fixtures.

B. Corridors: Corridor lighting shall be programmed to operate on two schedules; Before & after school hours and during school hours.

C. Before & after school: Corridor lighting shall operate on/off by occupancy sensor. When occupancy is detected the lights shall illuminate to 50% output and turn off after 15 minutes of vacancy. Local controls bring lighting up to 100% for a 2-hour duration.

D. During school: Corridor lights are on 100%. The local override controls are disabled or programmed on only.

E. Girl & Boy Multi-Fixture Restrooms: Lights are controlled with corridor schedule during school hours. The hand wash area fixtures are full output during school hours. The restroom light fixtures are to be on at 30% output in vacancy mode. Occupancy detection automatically brings light level up to 100% output. Before & after school hours the occupancy sensors control lights; 100% on/off. Lights turn off after 15-minute vacancy.

F. Staff Multi-Fixture Restrooms: Occupancy detection automatically brings light level up to 100% output. Before & after school hours the occupancy sensors control lights; 100% on/off. Lights turn off after 15-minute vacancy.

G. Private Restrooms: Line voltage occupancy sensors with manual controls shall be programmed to be manual on/time off after a 15-minute duration of vacancy.

H. Large Storage rooms: Manual on/time off after a 15-minute duration of vacancy.

I. Janitor & Small Storage Rooms: Line voltage occupancy sensors with manual controls shall be programmed to be manual on/time off after a 15-minute duration of vacancy.

J. Offices: Manual on/time off after a 15-minute duration of vacancy.

K. Conference, Reception, Therapy, Faculty & Workrooms: All fixtures are controlled by the digital controller, occupancy sensors & daylight sensors located within the room. The room shall be configured to require manual on, vacancy off and automatic adjustment of all lighting located within the designated daylight zones. The digital controller shall provide manual on/off and dimming. The occupancy sensors shall be programmed for vacancy off after a 15-minute time period. The daylight sensors shall dim the fixtures located within the daylight zones to maintain a minimum 30 FC light level from combined artificial and daylight on all horizontal and vertical work surfaces.

L. Gymnasium, Commons & Multi-Purpose Rooms: All fixtures are controlled by the digital controller, high volume occupancy sensors & daylight sensors located within the room. The room shall be configured to require manual on, vacancy off and automatic adjustment of all lighting located within the designated daylight zones. The digital controller shall provide manual on/off and dimming. The occupancy sensors shall be programmed for vacancy off after a 15-minute time period. The daylight sensors shall dim the fixtures located within the daylight zones to maintain a minimum 30 FC light level from combined artificial and daylight on all horizontal and vertical work surfaces.

M. Kitchen & Music/Stage: All fixtures are controlled by the digital controller & occupancy sensors located within the room. The room shall be configured to require manual on/vacancy off. The digital controller shall provide manual on/off and dimming. The occupancy sensors shall be programmed for vacancy off after a 15-minute time period.

N. Mechanical, Electrical & Data rooms: All fixtures shall be manual on/off.

O. HVAC: Classroom, offices, workrooms, library, break rooms and other spaces requiring vacancy sensing interface with HVAC equipment shall be provided with auxiliary contacts or modules for Division 23 connection. See mechanical.

P. Stairs: Lights shall be illuminated to 50% output whenever the building is occupied. Lights shall automatically turn on when the intrusion alarm system is de-activated. When occupancy is detected by the stair sensors, the lighting output shall go to 100% for a duration of 15 minutes then reset to 50% output. When the intrusion alarm system is activated, the stair lights shall turn off.

Q. Exterior Building: Photocell on/Time off. All building lights shall automatically come on at dusk. The building egress lights shall turn off at a time of day (TOD) as selected by the owner. General building lights shall reduce the light output to 50% at a TOD selected by the owner. All building fixtures shall be timed on at a selected TOD in the morning and automatically turn off at dawn.

R. Parking and walkway lighting: All parking and walkway lighting shall automatically come on at dusk. All parking and walkway lights shall reduce the light output to 50% at a TOD selected by the owner. All fixtures shall be timed on at a selected TOD in the morning and automatically turn off at dawn.

3.4 ADJUSTMENT, TESTING, DEMONSTRATION & COMISSIONING

A. Notify the Owner's Representative and the Commissioning Authority at least two (2) weeks in advance of the date of each test, to allow witnessing of the tests.

B. The automatic lighting control devices are subject to commissioning. The Electrical Contractor shall assist the Commissioning Authority with scheduling and coordinating commissioning activities, developing commissioning test procedures, conducting commissioning tests, preparing commissioning documentation, and developing a training plan in accordance with specific responsibilities as assigned in Section 01 9100 and Section 26 0510. Prior to the start of functional

performance testing for commissioning purposes, complete all start-up and checkout procedures and verify that the equipment is completely ready to be tested. A knowledgeable electrician in the employ of the Electrical Installer shall be present during functional performance testing for commissioning purposes.

C. The Contractor is to supply tools, instruments, gauges, testing equipment, protective devices and safety equipment for adjustment, testing and demonstration as needed.

D. Prior to system testing, the Electrical Contractor shall prepare a list of the devices to be tested, together with the associated location of each device and device identification (bar code number, ID, etc.). Include space to indicate test response for each device .

E. During adjustment and testing, the Electrical Contractor shall carefully record all settings and all test results, including expected test results, actual test results, and corrective actions taken. Records shall be submitted to the Architect's Consultant and included in the Operating & Maintenance Manuals. A device settings report from applicable software is also acceptable documentation.

F. Initial Set-up: Verify that wiring is correctly connected to each device. Adjust controls to function as specified under the sequence of operation. Settings shall comply with direction received from the Architect's Consultant and/or sequence of operation. Default to IES light levels if information is not available at time of initial set up.

G. For each room with day lighting controls calibration shall be performed on a day with sufficient daylight. The Electrical Contractor shall schedule additional visits as necessary if conditions are not correct for calibration. Follow manufacturer recommendations.

H. Program sequences of operation that include time functions to operate at times selected by the Owner's Representative. Information must be available before the technician is scheduled for start-up.

I. Field Testing: Test all system features for proper function. Tests to be performed shall include, but not be limited to, the following:
   1. Verify the sequence of operation for each device.
   2. Verify the setting and accuracy of each timing function in each device.
   3. Verify that each manual override control functions properly.
   4. Verify that occupancy sensors do not remain actuated due to normal conditions (e.g., air movement).
   5. Verify that occupancy sensors are actuated by hand motion within the entire area of coverage.
   6. Verify that occupancy sensors actuate when a person enters the area of coverage.
   7. Measure the illumination level in daylight zones equipped with daylight harvesting controls.
   8. Correct any deficiencies discovered as a result of the above testing, and completely retest the work affected by such corrections as part of the required installation and testing.

3.5 ON-SITE TRAINING

A. After the system has been completed, tested and is operating properly, the manufacturer's representative shall demonstrate by actual usage, the proper operation of each system device and function in the presence of the Owner's Representative. Demonstration shall include repetition of selected field tests, as well as additional adjustment or testing required to demonstrate that the system performs in accordance with the operational description as specified herein and the Owner's operational requirements.

B. On-site training shall be coordinated with the Commissioning Authority in accordance with Sections 01 9100 and 26 0800. At least two (2) months prior to the anticipated training session, submit a draft of the training plan and the proposed participants to the Commissioning Authority for review and comment. Two (2) weeks prior to the scheduled training, submit to the Commissioning Authority a revised written training plan incorporating the Commissioning Authority's comments.

C. The Electrical Contractor shall coordinate end user training to be conducted after the Operating and Maintenance Manuals for the project are completed and available for use during the training session.

D. An authorized factory representative shall conduct two (2) hours minimum of training for the Owner's maintenance personnel in the operation and maintenance of the lighting controls and applicable software. Training time shall be extended as necessary to satisfy the Owner's Representative that all pertinent topics have been adequately covered.

E. The Electrical Contractor shall maintain a training sign-in sheet, upon which participants in the training session, including the instructors, shall record their names. The training sign-in sheet shall be dated.

F. On-site training shall follow a written training plan, prepared in advance. The training plan shall outline the topics to be covered, the publications to be used, and the training schedule.

G. The training shall be conducted by technicians who are thoroughly familiar with the equipment and its features, and also with the Project. The training shall include instruction, field demonstration, and over-the-shoulder hands-on exercises. As a minimum, the training shall cover, but not be limited to, the following topics:
   1. General overview of lighting controls, including purpose and principle of operation.
   2. Location of lighting control components.
   3. Interpretation of equipment output devices, such as indicators and status contacts.
   4. Control adjustments and settings.
   5. Operation of system controls, including over-ride switches.
   6. Recommended maintenance procedures and intervals.

H. At the conclusion of the training session, the Electrical Contractor shall obtain written sign-off from the Commissioning Authority and the Owner's Representative. Insert a copy of the sign-off form and the training sign-in sheet into the Operating and Maintenance Manuals. Submit another copy of the training sign-in sheet to the Architect.

END OF SECTION 26 09 23

SECTION 26 09 43 - NETWORK LIGHTING CONTROLS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section.

1.2 SUMMARY

A. The lighting control system specified in this section shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control.

B. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed)

C. All system devices shall be networked together enabling digital communication and shall be individually addressable.

D. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity even if network connectivity to the greater system is lost.

E. The system architecture shall facilitate remote operation via a computer connection.

F. The system shall not require any centrally hardwired switching equipment.

1.3 DEFINITIONS

A. LCP: Lighting Control Panel

1.4 SUBMITTALS

A. Product Data: Submit for each type of product provided.

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this project

1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
2. Block Diagram: Show interconnections between components specified in this section and devices furnished with power distribution system components. Indicate data communication paths and identify repeaters, emergency modules, interface modules, and other devices to be used.
3. Wiring Diagrams: Show all power, signal and control wiring connections. Coordinate nomenclature and presentation with a block diagram.

1.5 WARRANTY

A. All devices in lighting control system shall have a 5-year warranty.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products by following:

1. Acuity Controls nLight
2. Hubbell NX (except for wireless version)

3. Intelligent Lighting Controls (ILC)

2.2 SYSTEM REQUIREMENTS

A. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time-based operation.

B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.

C. System must interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches (see *Networked LED Luminaire* section)

D. Intelligent lighting control devices shall communicate digitally, require <4 mA of current to function (Graphic wall stations excluded), and posses RJ-45 style connectors.

E. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher-level network backbone.

F. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.

G. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.

H. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.

I. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone “bus power supplies” shall not be required in all cases.

J. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e., not in a remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.

K. System shall have one or more primary wall mounted network control “gateway” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.

L. System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.

M. System shall be capable of wirelessly connecting a lighting zone to a WiFi (802.11n) wireless data network for purposes of eliminating the “bridge” devices and all cabling that connects zones to bridge devices.

N. WiFi enabled devices shall be able to detect when WiFi network is down and revert to a user directed default state.

O. WiFi-enabled devices shall be capable of current monitoring

P. WiFi-enabled devices shall utilize WPA2 AES encryption

Q. WiFi-enabled devices shall be able to connect to 802.11b/g/n WiFi networks

R. WiFi-enabled devices shall have at least one local RJ-45 port for communicating with nonWiFi-enabled system devices

S. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.

T. Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.

U. Devices located in different lighting zones shall be able to communicate occupancy, photocell, and switch information via either the wired or WiFi backbone.

V. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week utilization of a space. Note operating modes should be utilized only in manners consistent with local energy codes.

1. Auto-On / Auto-Off (via occupancy sensors)
   a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
   b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
   c. Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic On functionality.
2. Manual-On / Auto-Off (also called Semi-Automatic)
   a. Pushing a switch will turn lights on.
   b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
3. Manual-On to Auto-On/Auto-Off
   a. Pushing a switch will turn lights on.
   b. After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.
   c. Sequence can be reset via scheduled (ex. daily each morning) events
4. Auto-to-Override On
   a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
   b. Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
   c. Sequence can be reset via scheduled (ex. daily each morning) events
5. Manual-to-Override On
   a. Pushing a switch will turn lights on.
   b. Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
   c. Sequence can be reset via scheduled (ex. daily each morning) events
6. Auto On / Predictive Off
   a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
   b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
   c. If switch is pressed, lights turn off and a short “exit timer” begins. After timer expires, sensor scans the room to detect whether occupant is still present. If no occupancy is detected, zone returns to auto-on. If occupancy is detected, lights must be turned on via the switch.
7. Multi-Level Operation (multiple lighting levels per manual button press)

a. Operating mode designed specifically for bi-level applications
b. Enables the user to cycle through the up to four potential on/off lighting states using only a single button.
c. Eliminates user confusion as to which of two buttons controls which load
d. Three different transition sequences are available in order to comply with energy codes or user preference)
e. Mode available as a setting on all nLight devices that have single manual on/off switch (ex. nWSX, nPODM, nPODM-DX).
f. Depending on the sequence selected, every button push steps through relays states according to below table
g. In addition to achieving bi-level lighting control by switching loads with relays, the ability to command dimming outputs to “step” in a sequence that achieves bi-level operation is present.

	Alternating Sequence		Full On Sequence		3 Step On Sequence	
Sequence State #	Relay 1	Relay 2	Relay 1	Relay 2	Relay 1	Relay 2
1	On	Off	On	Off	On	Off
2	Off	On	-	-	Off	On
3	-	-	On	On	On	On
4*	Off	Off	Off	Off	Off	Off

(*step only present for devices without separate off button)

W. A taskbar style desktop application shall be available for personal lighting control.

X. An application that runs on “smart” handheld devices (such as an Apple® IPhone®) shall be available for personal lighting control.

Y. Control software shall enable logging of system performance data and presenting useful information in a web-based graphical format and downloadable to .CSV files.

Z. Control software shall enable integration with a BMS via BACnet IP.

AA. System shall provide the option of having pre-terminated plenum rated CAT-5 cabling supplied with hardware.

2.3 INDIVIDUAL DEVICE SPECIFICATIONS

A. Control Module (Gateway)

1. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet.
2. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.
3. Control device shall have three RJ-45 ports for connection to other backbone devices (bridges) or directly to lighting control devices.
4. Device shall automatically detect all devices downstream of it.
5. Device shall have a standard and astronomical internal time clock.
6. Device shall have one RJ-45 10/100 BaseT Ethernet connection.

7. Device shall have a USB port
8. Each control gateway device shall be capable of linking 1500 devices to the management software.
9. Device shall be capable of using a dedicated or DHCP assigned IP address.
10. Network Control Gateway device shall be the following Sensor Switch Model Series:
    a. nGWY2

B. Networked System Occupancy Sensors

1. Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.
4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
5. All sensing technologies shall be acoustically passive meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
6. Sensors shall be available with zero, one, or two integrated Class 1 switching relays, and up to one 0-10 VDC dimming output. Sensors shall be capable of switching 120 / 277 / 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor. Relays shall be dry contacts.
7. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.
8. Sensors shall be available in multiple lens options which are customized for specific applications.
9. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
10. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.
11. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue
12. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
13. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.
14. Sensors shall be equipped with an automatic override for 100-hour burn-in of lamps. This feature must be available at any time for lamp replacements.
15. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.
16. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load

wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.

17. Wall switch sensors shall have optional features for photocell/daylight override, vandal resistant lens, and low temperature/high humidity operation.
18. Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, Gray)
19. Wall switch sensors shall be available with optional raise/lower dimming adjustment controls
20. Wall switch sensors shall be the following Sensor Switch model numbers, with device color and optional features as specified:
    a. nWSD or nWSX (PIR, 1 Relay)
    b. nWSD PDT or nWSX PDT (Dual Tech, 1 Relay)
    c. nWSD NL (PIR w/ Night Light, 1 Relay)
    d. nWSD PDT NL (Dual Tech w/ Night Light, 1 Relay)
    e. nWSX NL LV (PIR w/ Night Light, No Relay)
    f. nWSD PDT NL LV (Dual Tech w/ Night Light, No Relay)
    g. nWSD LV or nWSX LV (PIR, No Relay, Raise/Lower Dim Ctrl)
21. nWSD PDT LV or nWSX PDT LV (Dual Tech w/ Night Light, No Relay, Raise/Lower Dim Ctrl)
22. Network system shall have sensors that can be embedded into luminaire such that only the lens shows on luminaire face.
23. Embedded sensors shall be capable of both PIR and Dual Technology occupancy detection
24. Embedded sensors shall have an optional photocell
25. Embedded sensors shall be the following Sensor Switch model number:
    a. nES 7 (PIR, No Relay)
    b. nES 7 ADCX (PIR w/ Photocell, No Relay)
    c. nES PDT 7 (Dual Technology, No Relay)
    d. nES PDT 7 ADCX (Dual Technology w/ Photocell, No Relay)
26. Network system shall also have ceiling, fixture, recessed, & corner mounted sensors available.
27. Fixture mount sensors shall be capable of powering themselves via a line power feed.
28. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.
29. Sensors with dimming can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current (typically 40 or more ballasts).
30. Sensors shall be the following Sensor Switch model numbers, with device options as specified:

Model # Series	Occupancy Poles	# of Relays	Lens Type	Detection Technology
nCM(B) 9	1	-	Standard	PIR
nCM(B) 9 2P	2	-	Standard	PIR
nCMR(B) 9	1	1	Standard	PIR
nCMR(B) 9 2P	2	2	Standard	PIR
nCM(B) PDT 9	1	-	Standard	Dual
nCM(B) PDT 9 2P	2	-	Standard	Dual
nCMR(B) PDT 9	1	1	Standard	Dual
nCMR(B) PDT 9 2P	2	2	Standard	Dual
nCM(B) 10	1	-	Extended	PIR
nCM(B) 10 2P	2	-	Extended	PIR
nCMR(B) 10	1	1	Extended	PIR
nCMR(B) 10 2P	2	2	Extended	PIR

nCM(B) PDT 10	1	-	Extended	Dual
nCM(B) PDT 10 2P	2	-	Extended	Dual
nCMR(B) PDT 10	1	1	Extended	Dual
nCMR(B) PDT 10 2P	2	2	Extended	Dual
nWV 16	1	-	Wide View	PIR
nWV PDT 16	1	-	Wide View	Dual
nHW13	1	-	Hallway	PIR
nCM(B) 6	1	-	High Bay	PIR
nCMR(B) 6	1	1	High Bay	PIR
nCMR(B) 6 2P	2	2	High Bay	PIR
nCMR(B) 6 480	1	2	High Bay	PIR

Note: Recessed mount versions of the above ceiling (fixture) mount versions also shall be available (e.g. nCMR(B) 9 => nRMR 9)

31. System shall have WiFi enabled fixture mountable sensors available.
32. Embedded sensors shall have an optional photocell and 0-10 VDC dimming output
33. WiFi enable sensors shall be one of the Sensor Switch model numbers:
    a. nCMRB 6 WIFI (PIR, w/ Relay)
    b. nCMRB 10 WIFI (PIR, w/ Relay)
    c. nCMRB 50 WIFI (PIR, w/ Relay)
    d. nCMRB 9 WIFI (PIR, w/ Relay)

C. Networked System Daylight (Photocell and or Dimming) Sensors

1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
2. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
4. Dimming sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of class 2 current (typically 40 or more ballasts).
5. Photocell and dimming sensors shall be equipped with an automatic override for 100-hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)
6. Combination units that have all features of on/off photocell and dimming sensors shall also be available.
7. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.
8. Line voltage versions of the above described photocell and combination photocell/dimming sensors shall be capable of switching both 120 VAC, 277 VAC, and 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor load. Relays shall be dry contacts.
9. Sensor shall be the following Sensor Switch model numbers, with device options as specified:
    a. nCM(B) PC (on/off))
    b. nCM(B) ADC (dimming)
    c. nCM(B) PC ADC (on/off, 0-10 VDC dimming)
    d. nCMR(B) PC (on/off, single relay)

e. nCMR(B) PC ADC (on/off, 0-10 VDC dimming, single relay)

Note: Recessed mount versions of the above ceiling (fixture) mount versions also shall be available (e.g. nCMR (B) PC => nRMR PC)

10. Network system shall have dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
11. Embedded sensors shall be the following Sensor Switch model number:
    a. nES ADCX (Dimming Photocell)

D. Networked System Power (Relay) Packs

1. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
3. All devices shall have two RJ-45 ports.
4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
7. Power Packs and Power Supplies shall be available that are WiFi enabled.
8. Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all lighting load types.
9. Power (Secondary) Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.
10. Specific Secondary Packs shall be available that provide up to 5 Amps of switching as well as 0-10 VDC dimming of fluorescent ballasts/LED drivers.
11. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
12. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
13. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
14. Specific Secondary Packs shall be available that provide up to 5 Amps of switching of dual phase (208/240/480 VAC) lighting loads.
15. Specific Secondary Packs shall be available that require a manual switch signal (via a networked Wall Station) in order to close its relay.
16. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.
17. Specific Secondary Packs shall be available that control louver/damper motors for skylights.

18. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
19. Power (Relay) Packs and Supplies shall be the following Sensor Switch Model Series:
    a. nPP16 (Power Pack w/ 16A relay)
    b. nPP16 WIFI (Power Pack w/ 16A relay, WIFI enabled)
    c. nEPP5 D (Power Pack w/ 5A relay and 0-10VDC dimming output)
    d. nSP16 (Secondary Pack w/ 16A relay)
    e. nSP5 2P (Secondary Pack w/ two 5A relays)
    f. nSP5 D (Secondary Pack w/ 5A relay and 0-10VDC dimming output)
    g. nPP16 ER (UL924 Listed Secondary Pack w/ 16A relay for switching emergency power circuits)
    h. nSP5 D ER (UL924 Listed Secondary Pack w/ 5A relay and 0-10VDC dimming output for switching emergency power circuits)
    i. nSP5 PCD 2W (Secondary Pack w/ 5A relay and incandescent dimming or 2-wire line voltage fluorescent dimming output)
    j. nSP5 PCD 3W (Secondary Pack w/ 5A relay and 3-wire line voltage fluorescent dimming output)
    k. nSP5 PCD MLV (Secondary Pack w/ 5A relay and magnetic low voltage dimming output)
    l. nSP5 PCD ELV 120 (Secondary Pack w/ 4A relay and electronic low voltage dimming output)
    m. nSP5 480 (Secondary Pack w/ 5A relay for switching 208/240/480 VAC loads
    n. nSP5 2P LVR (Louver/Damper Control Pack
    o. nSHADE (Pulse On/Off Control Pack
    p. nPS 80 (Auxiliary Bus Power Supply)
    q. nPS 80 WIFI (Auxiliary Bus Power Supply, WiFi enabled)
    r. nAR 40 (Low voltage auxiliary relay pack)

E. Networked System Relay & Dimming Panels

1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.
2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
3. Panel shall provide one 0-10VDC dimming output paired with each relay.
4. Panel shall power itself from an integrated 120/277 VAC supply.
5. Panel shall be capable of operating as either two networked devices or as one.
6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.
7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection
8. Power (Relay) Packs and Supplies shall be the following Sensor Switch model numbers:
    a. nPANEL 4 (Panel w/ four 120/277 VAC relays and four 0-10 VDC dimming outputs)
    b. nPANEL 2 480 (Panel w/ two dual phase relays (208/240/480 VAC) and two 0-10 VDC dimming outputs)

F. Networked Auxiliary Input / Output (I/O) Devices

1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
2. Devices shall have two RJ-45 ports
3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current (typically 40 or more ballasts).
5. Specific I/O devices shall have an input that read a 0-10 VDC signal from an external device.
6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, run a local/remote control profile, or raise/lower a dimming output
7. Specific I/O devices shall sense state of low voltage outdoor photocells
8. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.
9. Specific I/O devices shall sense.
10. Auxiliary Input/Output Devices shall be the following Sensor Switch model numbers:
    a. nIO D (I/O device with 0-10 dimming output)
    b. nIO 1S or nIO RLX (I/O device with contact closure or 0-10VDC dimming input)
    c. nIO NLI (Input device for detecting state of low voltage outdoor photocell; sold in nIO PC KIT only)
    d. nIO X (Interface device for communicating with RS-232 enabled AV Touch Screens

G. Networked LED Luminaires

1. Networked LED luminaire shall have a mechanically integrated control device
2. Networked LED luminaire shall have two RJ-45 ports
3. Networked LED luminaire shall be able to digitally network directly to other network control devices (sensors, photocells, switches, dimmers)
4. Networked LED luminaire shall provide low voltage power to other networked control devices
5. System shall be able to turn on/off LED luminaire without using a relay
6. System shall be able to maintain constant lumen output over the specified life of the LED luminarie (also called lumen compensation) by varying the input control power (and thus saving up to 20% power usage).
7. System shall indicate (via a blink warning) when the LED luminaire has reached its expected life (in hrs).

H. Networked System Wall Switches & Dimmers

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Devices shall be available with zero or one integrated Class 1 switching relay.
3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
4. All sensors shall have two RJ-45 ports.
5. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
6. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
7. Devices with dimming control outputs can control 0-10 VDC dimmable ballasts by sinking up to 20 mA of current (typically 40 or more ballasts).
8. Devices with capacitive touch buttons shall provide audible user feedback with different sounds for on/off, raise/lower, start-up, and communication offline.
9. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
10. Devices with mechanical push-buttons shall be made available with custom button labeling
11. Devices with a single on button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which

of two buttons (as is present in multi-button scenarios) controls which load is eliminated.

12. Wall switches & dimmers shall be the following Sensor Switch model numbers, with device options as specified:
    a. nPOD (single on/off, capacitive touch, audible user feedback)
    b. nPOD 2P (dual on/off, capacitive touch, audible user feedback)
    c. nPODR (single on/off, one relay, capacitive touch, audible user feedback)
    d. nPODM (single on/off, push-buttons, LED user feedback)
    e. nPODM 2P (dual on/off, push-buttons, LED user feedback)
    f. nPODM DX (single on/off, single dimming raise/lower, push-buttons, LED user feedback)
    g. nPODM 2P DX (dual on/off, dual dimming raise/lower, push-buttons, LED user feedback)
    h. nPODM 4P (quad on/off, push-buttons, LED user feedback)
    i. nPODM 4P DX (quad on/off, quad dimming raise-lower, push-buttons, LED user feedback)

I. Networked System Graphic Wall Station

1. Device shall have a 3.5” full color touch screen for selecting up to 8 programmable lighting control presets or acting as up to 16 on/off/dim control switches.
2. Device shall enable configuration of lighting presets, switched, and dimmers via password protected setup screens.
3. Device shall enable user supplied .jpg screen saver image to be uploaded.
4. Device shall surface mount to single-gang switch box
5. Device shall have a micro-USB style connector for local computer connectivity.
6. Device shall have two RJ-45 ports for communication
7. Device shall be the following Sensor Switch model number:
    a. nPOD GFXNetworked System Scene Controllers

1. Device shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.
2. Device shall recess into single-gang switch box and fit a standard GFI opening.
3. Devices shall provide LED user feedback.
4. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
5. All sensors shall have two RJ-45 ports.
6. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
7. Device shall be capable of selecting a lighting profile be run by the system’s upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
8. Device shall have LEDs indicating current selection.
9. Scene Selector device shall be the following Sensor Switch model number:
    a. nPODM 2S (2 Scene, push-button)
    b. nPODM 4S (4 Scene, push-button)
    c. nPODM 4S DX (4 Scene, push-button, On/Off/Raise/Lower)
    d. nPODM 4L DX (4 Adjustable Presets, push-button, On/Off/Raise/Lower)

K. Communication Bridges

1. Device shall surface mount to a standard 4” x 4” square junction box.
2. Device shall have 8 RJ-45 ports.
3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.

4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.
5. Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.
6. Communication Bridge devices shall be the following Sensor Switch model numbers:
   a. nBRG 8 (8 Ports)

2.4 LIGHTING CONTROL PROFILES

A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.

B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.

C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.

D. Every device parameter (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.

E. All lighting control profiles shall be stored on the network control gateway device and on the software's host server.

F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.

G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.

H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.

I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.

J. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

2.5 MANAGEMENT SOFTWARE

A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software

B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).

C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.

D. A printable network inventory report shall be available via the software.

E. A printable report detailing all system profiles shall be available via the software.

F. Software shall require all users to login with a User Name and Password.

G. Software shall provide at least three permission levels for users.

H. All sensitive stored information and privileged communication by the software shall be encrypted.

I. All device firmware and system software updates must be available for automatic download and installation via the internet.

J. Software shall be capable of managing systems interconnected via a WAN (wide area network)

2.6 BMS COMPATIBILITY

A. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software. No additional hardware shall be required.

B. BACnet IP gateway software shall communicate information gathered by networked system to other building management systems.

C. BACnet IP gateway software shall translate and forward lighting relay and other select control commands from BMS system to networked control devices.

2.7 SYSTEM ENERGY ANALYSIS & REPORTING SOFTWARE

A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.

B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.

C. An “Energy Scorecard” shall be display that shows calculated energy savings in dollars, KWHr, or CO_2.

D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc).

E. Energy savings data shall be calculated for the system as a whole or for individual zones.

F. A time scaled graph showing all relay transitions shall be presented.

G. A time scaled graph showing a zones occupancy time delay shall be presented

H. A time scaled graph showing the total light level shall be presented.

I. User shall be able to customize the baseline run-time hours for a space.

J. User shall be able to customize up to four time-of-day billing rates and schedules.

K. Data shall be made available via a .CSV file

2.8 START-UP & SUPPORT FEATURES

A. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.

B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.

C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.

D. All system devices shall be capable of being given user defined names.

E. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.

F. All sensor devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.

PART 3 – EXECUTION

3.1 WIRING INSTALLATION

A. Wiring Method: Install wiring in raceways except where installed in accessible ceilings and gypsum board partitions. Comply with Division 26, Section 26 0519, "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

E. Identify components and power and control wiring according to Division 26, Section 26 0553, "Identification."

3.2 COMMISSIONING

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 assist in field testing and programming.

B. Provide the following on-site support during construction:

1. Pre-installation conference with the Contractor.
2. Post-installation inspection to ensure the system is installed according to the manufacturer's requirements prior to programming.
3. Programming of all panels to accomplish the functions shown on the drawings and as specified herein.
4. Commissioning to verify the system operates as specified.
5. Initial Owner training (four hours minimum).
6. Final Owner training to be conducted approximately six months after substantial completion (four hours minimum).
7. 12 months after the date of Substantial Completion, provide on-site assistance in adjusting sensors and to assist Owner's personnel in making program changes to suit actual occupied conditions. Provide up to two visits to project during other than normal occupancy hours for this purpose.

C. Provide a written certification signed by the manufacturer stating the system has been commissioned.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls as described under "Commissioning." Refer to Division 01, Section 01 7900, "Demonstration and Training."

END OF SECTION 26 09 43

SECTION 26 2200 - LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Specification section 26 0573 Short Circuit Device Coordination and Arc Flash Study.

1.2 SUMMARY

A. This Section includes the following types of energy efficient dry-type transformers rated 600 V or less, with capacities up to 1000 kVA:
    1. Dry-Type Distribution transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated and vibration isolation.

B. Confirm equipment values comply with the results of the short circuit & arc flash report values prior to submitting the equipment provided under this section.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

D. Wiring Diagrams: Power, signal, and control wiring.

E. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

E. NEMA: ST20, TP-1, TP-2, TR-28-1975, TR-16-1975, 250

F. UL: 1561, 506

G. ANSI: C57 Standards

H. CSA: C22.2 (No. 47), 802.2-00

I. Code of Federal Regulations, 10 CFR Part 431, Energy Conservation.

J. State of Washington Legislation House Bill 1062.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not

energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide comparable products by one of the following manufacturers:
   1. ABB
   2. Eaton
   3. Siemens
   4. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
   1. Internal Coil Connections: Brazed or pressure type.
   2. Coil Material: Aluminum or Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2 (indoor), Type 3R [Type 4X] (outdoor).
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
   2. The terminal compartment shall be sized to permit wiring in accordance with NEC on deflection of conductors.
   3. A metal nameplate shall be affixed to the case of each transformer listing the following information as a minimum:

Manufacturer's Name	Catalog Number
Primary and Secondary Voltage	Type
KVA	Impedance
Serial Number	Wiring Diagram

   4. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.

D. Transformer Enclosure Finish: Comply with NEMA 250.
   1. Finish Color: Gray.

E. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.

I. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with NEMA TP 1, Class 1 efficiency levels.
   2. Tested according to NEMA TP 2.

J. Efficiency: Low-voltage dry-type distribution transformers shall have efficiencies not less than the applicable values in the following table when tested at 35% of the rated output power:

Single Phase		Three Phase	
Rated Power Output In KVA	Minimum Efficiency %	Rated Power Output In KVA	Minimum Efficiency %
>15 <25	97.7	>15 <30	97.0
>25 <37.5	98.0	>30 <45	97.5
>37.5 <50	98.2	>45 <75	97.7
>50 <75	98.3	>75 <112.5	98.0
>75 <100	98.5	>112.5 <150	98.2
>100 <167	98.6	>150 <225	98.3
>167 <250	98.7	>225 <300	98.5
>250 <333	98.8	>300 <500	98.6
333	98.9	>500 <750	98.7
		>750 <1000	98.8
		1000	98.9

K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
   1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
   2. Indicate value of K-factor on transformer nameplate.

L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
   1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
   2. Include special terminal for grounding the shield.
   3. Shield Effectiveness:
      a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
      b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
      c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
   4. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

5. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
   a. 50 kVA and Less: 45 db
   b. 51 to 150 kVA: 50 db
   c. 151 to 300 kVA: 55 db
   d. 301 to 500 kVA: 60 db
   e. 501 to 750 kVA: 62 db
   f. 751 to 1000 kVA: 64 db

2.4 VIBRATION ISOLATION AND NOISE CONTROL

A. Manufacturers: Subject to compliance with requirements, provide comparable products by one of the following manufacturers:
   1. Kinetics Noise Control
   2. Mason Industries
   3. Vibration Eliminator Co., Inc.

B. Submittals: Include rated load, spring diameters, and deflections and upon request, calculations signed by a registered engineer showing that the seismic loads the mountings are to resist have been properly calculated.

C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to ¼-inch- (6 mm) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and

   label products are specified in Division 26 Section "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

2.7 FIRE RATED SHEETING

A. Concrete board, ½ inch _13 mm) with fiberglass mesh, 4’ x 4’ or 4’ x 8’ sheets.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.2 INSTALLATION

A. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, and seismic codes applicable to Project.

B. Where indoor transformers not over 112.5 kVA are installed adjacent to combustible surfaces, provide a minimum 12” separation unless separated from the combustible material by a fire-resistant, heat insulated barrier to provide the NEC required separation from combustible material, per Article 450.

C. Transformers over 112.5 kVA shall be installed in a room with a minimum rating of 1 hour.

D. Where outdoor transformers are installed, locate to provide the NEC required separation from combustible material, per Article 450.

E. Install units on vibration mounts as specified; comply with manufacturer’s indicated installation instructions.

F. Locate all transformers to provide required clearances per NEC and manufacturer’s requirements.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. The final conduit connections to the transformer units shall utilize flexible conduit.

D. Tighten electrical and ground connections in accordance with equipment manufacturer’s published torque tightening values. Where manufacturer’s torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A and B.

E. Provide secondary overcurrent protection for all dry type transformers in accordance with Section 240 of the NEC.

F. Ground each transformer as a separately derived service. Provide equipment bonding jumpers and secondary grounding electrode per NEC requirements.

3.4 FIELD QUALITY CONTROL

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

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Measure db level at one foot, five feet and ten feet from each transformer. Provide test report to Architect and Engineer.

D. Remove and replace units that do not pass tests or inspections and retest as specified above.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION 26 22 00

SECTION 26 2413 – SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Specification section 26 0573 Short Circuit Device Coordination and Arc Flash Study.

1.2 SUMMARY

A. Section Includes:
   1. Service and distribution switchboards rated 600 V and less.
   2. Disconnecting and overcurrent protective devices.
   3. Instrumentation.
   4. Control power.
   5. Accessory components and features.
   6. Identification.

1.3 PERFORMANCE REQUIREMENTS

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

1.4 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Confirm equipment values comply with the results of the short circuit & arc flash report values prior to submitting the equipment provided under this section.

C. Shop Drawings: For each switchboard and related equipment.

D. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.

E. Detail enclosure types for types other than NEMA 250, Type 1.

F. Detail bus configuration, material type, current, and voltage ratings.

G. Detail short-circuit current rating of switchboards and overcurrent protective devices.

H. UL listing for switchboards suitable for use as service equipment (SUSE).
   1. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
   2. Include evidence of NRTL listing for rating of installed devices.
   3. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   4. Detail utility company’s metering provisions with indication of approval by utility company.
   5. Include schematic and wiring diagrams for power, signal, and control wiring.

I. Shop Drawings. Provide the following:

1. Include plan and elevation drawings indicating the equipment layout for the intended installation location. The shop drawings shall include all panelboards, transformers, transfer switches, etc., which are also located in the intended space.
2. The design documents indicate a general equipment layout only and are not intended to be a detailed installation plan. The design layout does not take into account the equipment dimensional differences between all of the listed approved manufacturers.
3. It shall be the contractor's responsibility to ensure that the equipment purchased for installation will fit in the space available and to insure compliance with all applicable code required working clearances.
4. Should it be determined that the space available is not sufficient for the manufacturer's equipment, the contractor shall develop a plan which is acceptable to the Owner, Architect and Engineer for placing the equipment in a satisfactory layout which meets all required working clearances.
5. No equipment shall be purchased without the contractor's verification that the space available is adequate for the intended manufacturer's equipment.

J. Contractor's Review: Prior to submitting the required material for the engineer's review the contractor shall review all documentation received from the manufacturer and make notations to correct non-compliant items. Prior to forwarding the reviewed documentation to for the Engineer's review; the contractor shall stamp the documents as 'Accepted' or 'Accepted as Noted'. Submittals which have not been pre-reviewed by the contractor or marked as previously stated shall be rejected by the reviewing Engineer.

K. Field Quality-Control Reports:
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

L. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

C. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

D. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

G. Comply with NEMA PB 2.

H. Comply with NFPA 70.

I. Comply with UL 891.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.7 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
      b. Altitude: Not exceeding 6600 feet (2000 m).

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet (2000 m).

1.8 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace defective materials or workmanship within specified warranty period.
   1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ABB
   2. Eaton
   3. Siemens
   4. Square D; Schneider Electric.

B. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Panel mounted.
   2. Branch Devices: Panel mounted.
   3. Sections front and rear aligned.

4. Removal of side or rear plates shall not be required for installation of switchboard or field connection of internal wiring.

C. Switchboards shall meet Underwriter's Laboratories enclosure requirements and be furnished with an Underwriter's Laboratories label. The Main Service Switchboard shall be UL listed as suitable for use as service equipment (SUSE),

D. Main-Bus Continuous: Amperage rating as indicated on the schedule or drawings.

E. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

F. Indoor Enclosures: Steel, NEMA 250, Type 1.

G. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

H. Barriers: Between adjacent switchboard sections.

I. Insulation and isolation for main and vertical buses of feeder sections.

J. Customer Metering Compartment: A separate customer metering compartment for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.

K. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
   2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
   3. Main Phase Bus: Uniform capacity, fully rated for switchboard ampacity for entire length of switchboard's main and distributions sections. Tapered bus is not allowed.
   4. Vertical Distribution Phase Bus: Uniform capacity, fully rated for section ampacity equal to the sum of all devices within the section including the maximum ampacity rating of all future devices.
   5. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
   6. Equipment Ground Bus: Uniform capacity for entire length of switchboard's main and distribution sections. Tapered bus is not allowed. Provide for future extensions from both ends. Pre-drilled bus for extension with standard splice plates.
   7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
   8. Coordinate and provide lugs sized for the conductors specified.

L. AIC Ratings:
   1. The switchboard and their overcurrent protection devices shall be fully rated for the interrupting capacity (AIC) indicated on the panel schedules [without the use of series rating] [series rating is acceptable provided the manufacturer provides series rating calculations and labeling as required by code.
   2. The available fault current (AFC) values indicated at the switchboard connection points, on the One-Line Diagram are the Engineer's calculated value and are shown for information only. The equipment shall meet or exceed the minimum required amperage interrupting capacity (AIC) value indicated on the schedules.

M. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
      c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
      d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      e. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.3 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
   1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound, bushing, bar or window type; single or double secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
   2. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
   3. Factory installed, UL (or other NRTL) listed.
   4. Basis of design: Square D Power Logic.

B. Multifunction Digital-Metering: Microprocessor-based unit capable of monitoring the quantity of loads indicated on the drawings, suitable for three- or four-wire systems, and with the following features:
   1. Monitoring and Metering:
      a. Phase Current: Ia, Ib, Ic, In
      b. Voltage: Va, Vb, Vc, Vab, Vbc, Vca
      c. Power: Hz, Watts, VA, VAR
      d. Demand: Record high demand (A, W, Va, VAR), 15-minute intervals
      e. Power Factor (A,B,C & total)
      f. THD voltage and current
      g. K Factor
      h. Harmonic Analysis through 63RD
      i. Wh, Vah, VARh
      j. Voltage and current unbalance
      k. Date & Time stamping
      l. Data & event log
   2. Communication:
      a. RS-485 Modbus
      b. Optional Ethernet connectability
      c. RS-232 (front accessible)
   3. Display
      a. Front
      b. Selectable

c. Digital LCD

C. Network Communications: the metering shall provide Modbus communications and solid state KY pulse output for communications with the building energy management system provided in Division 23.

D. Multi-Protocol Gateway: External DDCS interface gateway device to provide Modbus to BACnet communications. One for each meter as required. Basis of design: FieldServer Technologies ProtoNode RER.

E. Provide addressable branch monitoring modules and cable connected to meter for analysis of each branch.

2.4 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

B. Field installed switchboard nameplate indicating equipment identification acronym, voltage, phase and ampacity ratings.

C. Field installed main and branch device 4equipment identification.

D. NEC and WAC required flash protection labels.

2.5 CONCRETE HOUSEKEEPING PADS

A. Concrete shall meet the requirements of Division 03, 'Cast-in-Place Concrete'.

B. Concrete housekeeping pads; 4-inch (100-mm) minimum nominal thickness.

2.6 TVSS

A. TVSS Devices shall be Type 2 with 10 kA nominal discharge current and meeting UL1449.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

E. The switchboard must fit in the allotted space shown on drawings and meet all NEC required working clearances. All vendors bidding the project are required to verify spatial limitations prior to bid.

F. Acceptance of the manufacturers listed above is conditional upon compliance with the electrical and spatial requirements of the project.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Furnish and install switchboards on concrete housekeeping base, including the area for ‘future’ sections. Comply with requirements for concrete base specified in Division 03 Section ‘Cast-in-Place Concrete’.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Comply with NECA 1.

3.3 CONNECTIONS

A. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer’s published torque tightening values for equipment connectors. Where manufacturer’s torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A.

B. Coordinate energy use metering connections with Division 23.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnect, and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Perform tests, inspections and make adjustments per the manufacturer’s instruction and as specified.
   2. Manufacturer's Field Service: Engage a factory-authorized service representative for technical support and to assist in testing.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

4. The Contractor shall obtain the services of a testing service approved by the State of Washington Department of Labor and Industries to perform all testing of the ground fault protection system to verify compliance with NEC 230.95c requirements.
5. Confirm that the neutral is grounded only at the service equipment by removing the service neutral grounding conductor and meggering the neutral bus. If additional neutral grounds are detected, locate the source and retest until the neutral is clear of grounds. Other conductors shall not be energized while performing this test.

D. Switchboard will be considered defective if it does not pass tests and inspections.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Specification section 26 0573 Short Circuit Device Coordination and Arc Flash Study.

Retain or delete this article in all Sections of Project Manual.

1.2 SUMMARY

A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   1. Retain this article with "Seismic Qualification Certificates" Paragraph in "Submittals" Article for projects requiring seismic design. Model building codes and SEI/ASCE 7 establish criteria for buildings subject to earthquake motions. Verify requirements of authorities having jurisdiction.

Retain subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment must operate immediately after an earthquake.

   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.4 SUBMITTALS

A. First two paragraphs below are defined in Division 01 Section "Submittal Procedures" as "Action Submittals."

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Confirm equipment values comply with the results of the short circuit & arc flash report values prior to submitting the equipment provided under this section.

C. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Include evidence of NRTL listing for series rating of installed devices.
   6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   7. Include wiring diagrams for power, signal, and control wiring.
   8. Include plan and elevation drawings indicating the equipment layout for the intended installation location. The shop drawings shall include all panelboards, transformers, transfer switches, etc., which are also located in the intended space.

9. The design documents indicate a general equipment layout only and are not intended to be a detailed installation plan. The design layout does not take into account the equipment dimensional differences between all of the listed approved manufacturers.
10. It shall be the contractor's responsibility to ensure that the equipment purchased for installation will fit in the space available and to insure compliance with all applicable code required working clearances.
11. Should it be determined that the space available is not sufficient for the manufacturer's equipment, the contractor shall develop a plan which is acceptable to the Owner, Architect and Engineer for placing the equipment in a satisfactory layout which meets all required working clearances.
12. No equipment shall be purchased without the contractor's verification that the space available is adequate for the intended manufacturer's equipment.

D. Contractor's Review: Prior to submitting the required material for the Engineer's review the contractor shall review all documentation received from the manufacturer and make notations to correct non-compliant items. Prior to forwarding the reviewed documentation for the Engineer's review; the contractor shall stamp the documents as 'Accepted' or 'Accepted as Noted'. Submittals which have not been pre-reviewed by the contractor or marked as previously stated shall be rejected by the reviewing Engineer.

E. Panelboard Directories: Installed on the inside of the doorframe under the plastic cover and slot provided. The directory shall be typewritten with spares and spaces written in pencil. The Contractor shall identify the type of load and area served by each circuit using the permanent (end use) room numbers as determined by the Owner. Include all field changes and change order additions and deletions to the schedule. Attached copies of the panel schedules are not acceptable substitution.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
    2. Retain subparagraph below if final system short-circuit and coordination studies will be performed by designer or assigned to independent consultant. These curves are also beneficial to Owner for future additions or reevaluations of settings of overcurrent protective devices.

Remaining paragraphs are defined in Division 01 Section "Submittal Procedures" as "Informational Submittals."
Coordinate first paragraph below with qualification requirements in Division 01 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.
Retain first paragraph below if required by seismic criteria applicable to Project. Coordinate with Division 26 Section "Vibration and Seismic Controls for Electrical Systems." See SEI/ASCE 7 for certification requirements for equipment and components.
Retain first paragraph below if Contractor is responsible for field quality-control testing and inspecting.
Retain option in first paragraph below if retaining "Load Balancing" Paragraph in "Adjusting" Article.
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Retain first paragraph below if Contractor selects testing agency or if Contractor is required to provide services of a qualified testing agency in "Field Quality Control" Article. Qualification requirements are in addition to those specified in Division 01 Section "Quality Requirements," which also includes the definition for "NRTL" (nationally recognized testing laboratory).

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 PROJECT CONDITIONS

A. Retain first paragraph below for panelboards installed in typical environmental conditions. For panelboards installed outdoors, in unconditioned spaces, or in unusual environmental conditions, revise paragraph to indicate maximum ambient temperature and expected humidity range. See Editing Instruction No. 2 in the Evaluations.

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

3. In first subparagraph below, select first option for panelboards with fused switches; select second option for panelboards with circuit breakers.

a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

4. Retain first paragraph below or revise to accommodate unusual service conditions that cannot be eliminated. See Editing Instructions No. 2 and No. 3 in the Evaluations.

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

1.8 COORDINATION

A. Revise first paragraph below for types of equipment that affect panelboard installation.

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

Retain paragraph below if freestanding panelboards are specified.

1.9 WARRANTY

A. When warranties are required, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace defective materials or workmanship within specified warranty period.

1. Verify available warranties and warranty periods with manufacturers listed in Part 2 articles.

1. Warranty Period: One year from date of Substantial Completion.

1.10 EXTRA MATERIALS

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

2. Revise this article to include extra materials that Owner may require, such as GFCI or GFEP circuit breakers or circuit breakers used for switching service, which may fail more frequently due to continuous use.

Coordinate with Division 26 Section "Fuses" for quantities of spare fuses and spare-fuse cabinet to be provided.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: as scheduled.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets.

A. Retain first paragraph below for projects in seismic areas. Coordinate with "Submittals" Article for submittal of manufacturer's seismic qualification certification.

1. Rated for environmental conditions at installed location.

3. See "Enclosures" Article in the Evaluations for discussion of enclosure types. Coordinate first five subparagraphs below with Drawings (by identifying the designated areas) or schedules (by including the required enclosure type). Availability of some enclosure types are limited by a panelboard's ampacity rating, included devices, or physical size; consult manufacturers for availability of, and limitations on, other than Type 1 enclosures.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

4. Retain one of first two subparagraphs below.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:
   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. Flush Back Boxes: Galvanized steel.
   c. Surface Back Box in Utility Spaces, Electrical, Mechanical, Storage Rooms: Galvanized Steel.
   d. Surface Backboxes in Non-Utility Spaces: Finish to match panel and cover.

5. Retain first subparagraph below for installations in humid tropical environments.

Retain first subparagraph below for use with lighting and appliance branch-circuit and distribution panelboards with doors. With the increasing use of computer-generated directories, metal frames are becoming an expensive option for most manufacturers.

7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

C. Incoming Mains Location: Top or Bottom as determined by the contractor. Phase, Neutral, and Ground Buses:

6. Retain first paragraph below, and coordinate with Drawings and schedules, if Project requirements include identifying specific entry locations for incoming service or feeder raceways.

In first subparagraph below, first option is standard with most manufacturers; second option costs more.

1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
2. Bus structure shall have minimum full current ratings as indicated for the through bus. Section bus shall be equal to or greater than the sum of the maximum ampacity ratings of all devices, including provisions for future devices, in that section.
3. Provisions for future devices shall be such that no additional connectors or bus will be required to add devices.
4. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
5. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

7. Include instructions in first paragraph below if special sizing or oversizing of lugs is required, if allowing optional use of aluminum for circuits sized for copper conductors, or when upsizing conductors for voltage drop.

1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
8. Coordinate and provide lugs sized for the conductors specified.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals per UL 67 testing.

G. Available fault current values indicated on the One-Line Diagram are calculated and shown for plan review only. Provide equipment with the minimum short circuit current ratings indicated on the schedules.

2.2 DISTRIBUTION PANELBOARDS

A. Distribution panelboards, as specified in this article, fall under requirements of "Power Panelboards" in NFPA 70.

See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of first two paragraphs and list of manufacturers below. See Division 01 Section "Product Requirements."

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   8. Retain option in first paragraph below if manufacturer's name and model number are indicated in schedules or plans on Drawings; delete option and insert manufacturer's name and model number if not included on Drawings.
      1. ABB
      2. Eaton
      3. Siemens
      4. Square D; Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type (flush) latch with tumbler lock; keyed alike.
   9. Distribution panelboards, as standard, do not have doors; consult manufacturers for availability and types of doors. Retain first paragraph below if panelboards have doors.
      1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: Circuit breaker or Lugs only, as scheduled.

E. Branch Overcurrent Protective Devices: Bolt-on circuit breakers.

F. Instrumentation: Shall match that for Switchboards listed in Section 262413 2.03 for digital metering of loads shown on the drawings.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of first two paragraphs and list of manufacturers below. See Division 01 Section "Product Requirements."

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ABB
   2. Eaton
   3. Siemens
   4. Square D; Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only as scheduled.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of first two paragraphs and list of manufacturers below. See Division 01 Section "Product Requirements."

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ABB
   2. Eaton
   3. Siemens
   4. Square D; Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Coordinate two paragraphs below with Drawings. See the "Disconnecting and Overcurrent Protective Devices" Article in the Evaluations for guidance on making selections.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
   4. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
   5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
2. Not all accessories and options listed in subparagraphs below are available for every rating and from every listed manufacturer. Verify availability and unique characteristics with manufacturers selected.
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   e. Shunt Trip: 120V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
   f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
   g. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
   h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
   i. Handle Clamp: Loose attachment, for holding circuit-breaker handle in the on position.

2.04 Some manufacturers offer shunt-trip operators for their fused switches; however, most do not recommend using this feature for providing ground-fault protection on switches rated 1000 A and above in panelboards; they recommend using MCCBs or switches specified in Division 26 Section "Switchboards." Consult manufacturers for availability and limitations if this feature is required.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Retain this article for overcurrent protective devices that require items in paragraphs below; delete if these items are specified elsewhere, such as in Division 26 Section "Switchboards."

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

2.6 CONCRETE HOUSEKEEPING PADS

A. Concrete shall meet the requirements of Division 03, ‘Cast-in-Place Concrete’.

B. Concrete housekeeping pads; 4-inch (100-mm) minimum nominal thickness.

2.7 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for panelboards (SUSE) with one or more main service disconnecting and overcurrent protective devices.

B. Field installed panelboard nameplate indicating equipment identification acronym.

C. NEC and WAC required flash protection labels.

2.8 TVSS

A. TVSS Devices shall be Type 2 with 10 kA nominal discharge current and meeting UL1449.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

E. The panelboards must fit in the allotted space shown on the drawings and meet all NEC required working clearances.

F. Acceptance of the manufacturers listed above is conditional upon compliance with the electrical and spatial requirements of the project.

3.2 INSTALLATION

A.

B.

C. Referenced NECA and NEMA standards in first paragraph below include similar requirements. See "Testing and Inspecting" Article in the Evaluations.

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Equipment Mounting: Install Floor Mounted panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete".

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Retain first paragraph below for large floor-mounted distribution panelboards.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

E. Mount panelboard with uppermost handle no higher than +72” above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

H. Set field-adjustable, circuit-breaker trip ranges per power distribution study recommendations.

I. Install filler plates in unused spaces.

J. Stub four 1-inch empty conduits from each flush mounted panelboard section into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits [into raised floor space or] below slab not on grade. Stub one 1-1/2" inch empty conduit into accessible ceiling space or as indicated on the plans per each spare device greater than 60A.

K. Arrange conductors in gutters into groups and bundle and wrap with wire ties. Comply with NECA 1.

Retain first paragraph below if ceilings are accessible or there are raised floors, or when panelboards are located in spaces that will be finished.
Retain option in first paragraph below if retaining "Load Balancing" Paragraph in "Adjusting" Article.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Perform tests, inspections and make adjustments per the manufacturer's instructions and as specified.
   2. Manufacturer's Field Service: Engage a factory-authorized service representative for technical support and to assist in testing.

   A. Retain first two paragraphs below to describe tests and inspections to be performed.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where

manufacturer’s torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

Select first option in first paragraph below if settings are included in the Contract Documents; select second option if indicated Section is included in the Contract Documents.

END OF SECTION 26 24 16

SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Receptacles.
   2. Controlled receptacles.
   3. Tamper Resistant receptacles.
   4. Receptacles with integral GFCI.
   5. Twist-locking receptacles.
   6. Wall switches.
   7. Device plates.
   8. Cord reels.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.4 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for engraving wall plates.

C. Samples: When requested by owner or Architect, provide device and wall plate samples.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations
   1. Retain this Article if receptacles for Owner-furnished equipment with plugs have unknown or special configurations.
   2. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. General Description: Tamper Resistant straight blade, pre-wired modular plug type. NEMA 5-20R.

B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; TR5362_M
      b. Hubbell; SNAP5362_TR
      c. Leviton; M5362-_
      d. Legrand; PTTR63_

C. Occupancy Controlled, Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 ASHRAE 90.1-2010 and WSEC C405.10.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; TR5362CH_ (split duplex; half controlled)
      b. Hubbell; BR20C1_TR or SNAP5362C1_TRA (split duplex; half controlled), BR20C2_TR
      c. Leviton; 5362-1P (split duplex; half controlled)
      d. Legrand; TR5362CH (split duplex; half controlled)

D. Combination Duplex Outlet and duplex USB Type 2.0 Outlet (3-5A, 5VDC), Tamper Resistant Convenience Receptacles, 125 V, 20A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; TR7756_
      b. Hubbell; USB20A5_
      c. Leviton; T5832-_

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type, Decorator style, 125 V, 20A. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
   1. Duplex GFCI, Weather Resistant, Tamper Resistant, Convenience Receptacles, 125 V, 20 A. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; WRVGF20
      b. Hubbell; GFTWRST20SNAPW
      c. Leviton; W7899
      d. Pass & Seymour; 2095TRWR
   2. Color: White.

B. Duplex GFCI tamper resistant rated (TR):
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; TRSGF20
      b. Hubbell; GFR5352
      c. Leviton; GFTR2
      d. Pass & Seymour; 2097TR

C. GFCI Module, self-testing, flush face, 125V, 20A, Basis of Design; Hubbell GFBFHP20W

2.4 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
      b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
      c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
      d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
   2. Color: White.

C. Pilot Light Switches, 20A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 2221PL for 120 V and 277 V.
      b. Hubbell; HPL1221PL for 120 V and 277 V.
      c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
      d. Pass & Seymour; PS20AC1-PLR for 120 V.
   2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

2.5 WALL PLATES

A. Interior single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head stainless steel to match plate finish.
   2. Material for Finished Spaces: Stainless Steel, smooth, type 302.
   3. Material for Unfinished Spaces: Surface box galvanized steel with outside dimension to match box.

B. Exterior wet location covers shall be low profile single or two gang, NEMA 3R, UL rated for “extra duty”, in-use and compliant with NEC article 406. Covers shall be mountable to flush rough-in boxes and accept full size padlocks. Equal to Intermatic #WP1010MC.

2.6 PROTECTIVE COVERS

A. Protective device covers as manufactured by Safety Technologies International (STI) or approved equal.

B. Products: Subject to compliance with requirements, provide one of the following:
   1. Emergency Power Off (EPO) push buttons; STI #SS-2221PO-EN Yellow body, “EMERGENCY POWER OFF”
   2. Emergency Lockdown push button; STI #SS-2421LD-EN Blue body, “LOCKDOWN” text
   3. FA Manual Pull Station; See 28 31 00

C. Clear poly-carbonate, non-alarmed, hinged lift cover for protecting digital keypads, pushbuttons, emergency pushbuttons, fire drill test switch, access controls and other devices requiring damage protection or accidental device operation.

D. Exterior stations provide gasketed covers.

E. Label device plate under cover to denote function.

2.7 CORD REELS

A. Cord Reel, white housing, 20A, 120V, NEMA 4 rating, NEMA 5-20 configuration, #12AWG 3-wire SOW cord, 25’ length, with GFCI Module and yellow portable outlet box with (2) duplex receptacles. Hubbell #HBLI25123GF220. Cord reels with 208V receptacle shall be Hubbell #HBLI25123 cord reel only with receptacle field installed in a yellow portable outlet box by contractor.

2.8 PROHIBITED MATERIALS

A. The following materials are not allowed: Sectional device plates, non-metallic device plates or junction box cover.

2.9 EXTRA MATERIALS

A. Furnish and install the extra materials described in subparagraphs below that match products provided. This material shall be installed as directed during construction. The contractor shall consider normal installation conditions with the extra material being installed prior to cover. It shall be assumed that this work will occur below 12’-0” AFF.

B. Extra materials that are not installed during construction shall be turned over to the owner at the end of construction (closeout). Products that are not installed shall be packaged in their original containers with protective covering for storage and identified with labels describing contents.

C. The contractor shall include the following in their bid:
   1. 15 additional standard duplex receptacles per these specifications.
   2. 5 additional GFCI duplex receptacles per these specifications
   3. 20 rough-ins including (1) 4” square, deep box with single gang ring and 30’ of 2#12, 1#12G. (THHN) in 3/4" EMT conduit with (2) sweeps. Note: cut-in boxes and flex will be used if extra devices are to be located after wall finish.
   4. Labor for installing all extra materials.

D. Submit a fair cost value for these materials and labor with the Division 26 post bid submittals, on the form following this specification section. This fair cost estimate shall include all direct job expenses such as equipment rental, small tool expense, layout and supervision, etc. for a complete installation as if the material were shown on the drawings and taken off for bid. Breakout material and labor costs for each extra material indicated. Unused labor will be Architect or Engineer’s option. This fair cost value may be applied to other work not included in the bid documents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:
   1. NECA 1 referenced in paragraph below includes device mounting-height requirements. See "Product Selection and Application Considerations" Article in the Evaluations for device mounting heights in that standard.
   2. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   3. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   4. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   5. Install boxes flush with finish wall surface to provide proper fit of device and plate tight to wall with no gaps.

6. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Conductors:
      a. Cut back and pigtail or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailing conductors is permitted provided the outlet box is large enough.

D. Device Installation:
   1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
   5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
   6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
   7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
   8. Tighten unused terminal screws on the device.
   9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
   10. The self-grounding feature of receptacles shall not be used as the primary ground return. All receptacles shall have a green ground conductor installed to the ground screw from the circuit grounding conductor.
   11. Mounting Heights: All mounting heights indicated are the distances from the finished floor level to the bottom of the device box.
   12. Maximum Switch Height +44”
   13. Minimum Receptacle Height +16”
   14. Receptacles, located outdoors, kitchens, rooftops, within 6’-0” of sinks in restrooms and locker rooms, garages, shops, vehicle maintenance areas and any other area required by the NEC or local codes shall be GFCI type whether indicated on the drawings or not.

E. Receptacle Orientation:
   1. Retain subparagraph below if the position of the ground pin is important for consistency. Trade and professional literature is inconsistent in recommending benefits of either orientation.
   2. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Heavy Duty Cast Aluminum Weatherproof Covers:
   1. Cover flange exceeds box dimensions. Rough-in of flange is required during wall construction.
   2. Install cover per manufacturer’s instructions.

H. All exterior receptacles shall be GFCI, WR.

I. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

J. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

K. Controlled GFCI: Provide deep, 2-gang box with 2-gang ring. Mount the non-GFCI controlled receptacle adjacent to GFCI module in the common 2-gang box.

L. The contractor shall ensure that interior receptacles are located greater than 6'-0" from sink, water coolers, etc. Receptacles located within 6' of water sources shall be GFCI type. GFCI receptacles shall be readily accessible. Devices located under sinks, behind appliances, etc. in locations that GFCI protection is required shall be protected by circuit breaker.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."
   1. Receptacles: Identify panelboard and circuit number from which served. Use self-adhesive labeling machine, clear tape with 12 Pt black lettering on face of plate.

3.3 FIELD QUALITY CONTROL

A. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 26 27 26

SECTION 26 2813 – FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Cartridge fuses rated 600-V ac and less for use in enclosed switches.
   2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches.
   3. Fuse Box Covers.
   4. Spare-fuse cabinets.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. First paragraph below is defined in Division 01 Section "Submittal Procedures" as an "Action Submittal."
   2. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   3. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   4. Current-limitation curves for fuses with current-limiting characteristics.
   5. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
   6. Coordination charts and tables and related data.
   7. Fuse sizes for elevator feeders and elevator disconnect switches.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Paragraph below is defined in Division 01 Section "Submittal Procedures" as an "Informational Submittal."
      a. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
   4. Coordination charts and tables and related data.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

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

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bussmann, Inc.
   2. Littelfuse, Inc.
   3. Mersen

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

B. General purpose fuses 250V: Type FRNR.

C. General purpose fuses 600V: Type FRSR.

2.3 PLUG FUSES

A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-VAC. Fuse "Type" defines fuse performance category and base types. See Editing Instruction No. 3 and "Plug Fuses" Article in the Evaluations. Include current rating and type designations for plug fuses either on Drawings or in "Fuse Applications" Article.

2.4 PLUG-FUSE ADAPTERS

A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuseholders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

2.5 PLUG FUSE BOX COVER UNITS

A. Box Cover Units: 4" square box cover with plug fuse holder, on/off switch, single receptacle equal to Bussmann SSW or SSY.

2.6 SPARE FUSE CABINET

A. Fuse cabinet shall be of same type and finish as panelboards.

B. Cabinet shall be sized as required to contain spare fuses as required in Section 1.07. Provide a minimum of 3 spare fuses of each type and amperage for all the equipment furnished under division 26-28 in this project.

C. Arrange so fuses are stored on adjustable steel shelves with end of fuse carton exposed when door is open.

D. Cabinet shall have provisions for installation of directory card of size required to display information described in part 3. Card shall be behind glass cover.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Motor Branch Circuits: Class RK1, time delay.

B. Plug Fuses with box cover units for motor branch circuits 120V less than ½ HP: Plug Fuses: Edison-base type, dual-element time delay. Type T or TL for box cover units.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install plug-fuse adapters in Edison-base fuse holders and sockets. Ensure that adapters are irremovable once installed.

3.4 SPARE FUSE CABINET INSTALLATION

A. Install spare fuse cabinet and provide extra fuses stored inside their original packaging.

B. Provide typewritten directory card indicating all fusible devices, together with associated fuse size and type. Identify the equipment served by each type and size of fuse.

3.5 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 2816 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.5 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of NRTL listing for series rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1.6 QUALITY ASSURANCE

A. Comply with NETA or an NRTL testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

E. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
   2. Altitude: Not exceeding 6600 feet (2010 m).

1.8 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. The horsepower of motors and apparatus wattages indicated on the plans are estimated requirements of equipment furnished under other sections of the specifications. All switches and circuit breakers shall be of the sizes and capacities to suit the horsepower of the motors and equipment actually furnished.

C. Should equipment substitution result in additional electrical expense, the supplier making the substitution shall be responsible for the additional electrical design and installation expenses incurred by the Division 26 Engineer and Contractor. Prior to rough-in the Division 26 Contractor shall obtain a copy of all approved equipment submittals and verify all equipment connection requirements.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ABB
   2. Eaton
   3. Siemens
   4. Square D; Schneider Electric.

B. Type HD, Heavy Duty, Two or Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle in open or closed position with capability to accept three padlocks and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   4. Auxiliary Contact Kit:Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
   5. Hookstick Handle: Allows use of a hookstick to operate the handle.
   6. Lugs: Mechanical type, suitable for number, size, and conductor material. Lock Provisions: Interior: Lock off – Exterior: Lock on and off.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ABB
   2. Eaton
   3. Siemens
   4. Square D; Schneider Electric.

B. Type GD, General Duty, Single Throw, 120V ac, 30A, Non-Motorized Equipment: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Two or Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
   4. Hookstick Handle: Allows use of a hookstick to operate the handle.
   5. Lugs: Mechanical type, suitable for number, size, and conductor material. Lock Provisions: Interior: Lock off – Exterior: Lock on and off.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Wet Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

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

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Inspect components, assemblies, and equipment installations, including connections.
   2. Acceptance Testing Preparation:
   3. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   4. Test continuity of each circuit.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION 26 28 16

SECTION 26 2820 - ELEVATOR POWER MODULE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This section is a Division 26 Basic Electrical Materials section and is part of each Division 26 section.

B. Drawings and General Provisions of contract, including General and Supplementary Conditions, Division 01 Specification sections and all Division 26 sections, apply to work of this section.

1.2 SCOPE OF WORK

A. Provide and install all electrical material as described and detailed on the drawings.

B. Coordinate all rough-in and connections with the elevator manufacturer/installer, sprinkler installer and mechanical contractor.

1.3 QUALITY ASSURANCE

A. All electrical material provided under this section shall be a UL listed, manufactured assembly for the use intended.

B. The elevator power module panel (PMP) panel shall be manufactured by Bussmann. Field assemblies are unacceptable.

1.4 CODES

A. All work shall be performed in accordance with the latest edition of applicable standards, codes and laws.
   1. NFPA 70 620-51 A-B, 620-62, 645-10, 700-25 (FPN)
   2. ANSI/ASME A17.1 102.2(4)
   3. BOCA 30006.2.3

1.5 STANDARDS

A. Except as modified by governing codes, all equipment shall be manufactured in accordance with the latest applicable standards:
   1. Enclosed Switches, UL 98 and CSA-C22.2 No.

1.6 SUBSTITUTIONS

A. Substitutions shall comply with the requirements of the General Conditions and General Requirements. The names of manufacturers and model numbers have been used to establish types of equipment and standards of quality. A submittal shall contain sufficient information to prove compliance with Contract Documents. This includes compliance with all pertinent sections of modes and standards as specified above.

1.7 SUBMITTALS

A. Submit shop drawings and product data under the provisions of the General Conditions.

B. Product Data: Provide manufacturer’s catalog information showing dimensions, configurations, and methods of mounting and installation.

C. Submit listing of all types, sizes and quantity of fuses which will be installed including the location of each.

D. All options, part numbers, etc., shall be identified on the submittal.

E. All non-compliance items shall be listed/described in a cover letter.

PART 2 - PRODUCTS

2.1 ELEVATOR POWER MODULE SWITCH PANEL

A. This elevator switch panel specification is based on the Power Module™ switch as manufactured by Bussmann. Other manufacturers of similar products must submit for prior approval.

B. Provide an elevator switch panel in a single NEMA enclosure with all necessary relays, control transformer and other options (as listed below), and as shown on drawings. The elevator switch panel shall be constructed listed and certified to the standards as listed above.

C. The elevator switch(es) shall be a fusible switch, 100 amps, three pole, horsepower rated, shunt trip capable, non-automatic type. The switch shall have no instantaneous trip characteristics and shall be listed to UL98. LPJ 45A SP series dual element, time delay fuses shall be supplied to provide overcurrent protection. The ampere rating of the switch shall be based upon elevator manufacturer requirements and utilize Class J fuses (provided separately). It shall include as an accessory, a 100VA control power transformer with primary and secondary fuses. The primary voltage rating shall be 480 volts with a 120 volt secondary. It shall also contain an isolation relay (3PDT, 10 amp, 120V). The coil of the isolation relay shall be 120V. A 5A normally open dry contact shall be provided by the Fire Alarm Safety System to energize the isolation relay and activate the shunt trip solenoid (140VA inrush at 120V). (Note: If 24V DC coil is selected, a separate 24V DC source and contact must be provided by the Fire Alarm Safety System).

D. The module shall contain the following options:
   1. Control power transformer (CPT) 100VA with primary and secondary fusing
   2. Fire safety interface relay (3PDT, 10A, 120V)
   3. Key to test switch
   4. ‘On’ Pilot Light (green)
   5. Isolated Full Capacity Neutral Lug
   6. (1) NO and (1) NC mechanically interlocked contact (5A, 120VAC)
   7. Fire alarm (shunt trip) voltage monitoring relay
   8. NEMA 1 Enclosure

E. The module shall have been successfully tested to a short circuit rating with Class J fuses at 200,000 amps RMS symmetrical. All switches shall have shunt trip capabilities at 120V AC from remote fire safety signal. Branch feeders shall be selectively coordinated and fed with an upstream supply overcurrent protective device at a minimum of 2:1 size ratio utilizing (Class J, RK1 or L) fuses.

2.2 RECEPTACLES

A. All receptacles provided in the machine room or elevator pit shall be ground fault circuit interrupter type, 20A, duplex as specified in Section 26 27 26.

B. The pit receptacle shall be provided with an ‘in-use’ weatherproof cover.

2.3 LIGHT FIXTURES

A. Machine room light fixtures shall be enclosed LED as scheduled on the drawings.

B. Elevator pit light fixtures shall be enclosed, wet label LED with rough service acrylic lens cover and fiberglass housing.

2.4 LIGHT SWITCHES

A. Machine Room – SPST, 20A per Section 262726.

B. Elevator Pit: SPST, 20A, lighted handle (lit when in the ‘off’ position) per Section 262726.

2.5 HEAT DETECTORS

A. 135º, fixed temperature, 120V, non-system heat detectors.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Maintain 7'-0" clearance in the elevator machine room. Conduit may be installed in the upper space of the elevator machine room as long as they are installed above the required seven foot clearance and they do not interfere with the elevator equipment which also must be installed to allow a seven foot head clearance.

B. All conductors serving the elevator equipment shall be copper only. No aluminum conductors are allowed.

C. All disconnects, circuit breakers, etc. for elevator circuits are to have lockout devices. Coordinate exact location of elevator machine room disconnects and elevator switch panel within the machine room with the elevator installer.

D. Provide rough-in boxes and conduit for an emergency two-way communication system between the elevator cab and a designated point outside of the hoistway. The electrical contractor shall verify these requirements with the elevator manufacturer prior to rough-in.

E. Provide a dedicated ground conductor to the elevator switch panel. The conduit is not approved as a ground.

F. Provide the 480V, 3 phase line voltage connection to the elevator machine hoist.

G. Provide the 120V, single phase connections to the elevator controller.

H. Make all fire alarm and fire safety heat detection connections to the elevator switch panel.

I. Make the battery lowering, anti-power outage entrapment (APE) wiring connections between the elevator switch panel and machine.

J. The telephone cable shall be installed in ½" conduit. Install the telephone jack in a box with a plate. Coordinate jack location with the elevator manufacturer.

K. Coordinate the activation of the ADA monitoring service with the property owner.

3.2 COORDINATION

A. Coordinate the elevator power module switch panel and machine room panelboard locations with the elevator installer to maintain working clearances as required by the NEC and meet other governing codes.

B. Prior to rough-in, the Electrical Contractor shall obtain copies of the approved elevator submittals from the Architect to verify all electrical requirements. In the event of discrepancies, immediately notify the Architect and/ or Engineer.

C. Verify the fuse size required with the elevator manufacturer.

D. Coordinate the fixed temperature heat detector locations to be within 18" of sprinkler heads in pit, machine room and top of shaft.

3.3 ELEVATOR POWER MODULE SWITCH PANEL INSTALLATION

A. All material installation shall be in accordance with manufacturer's recommendations and the provisions of applicable codes.

B. Fuses shall not be installed until equipment is ready to be energized.

C. The elevator switch panel shall be located inside the elevator machine room, next to the doorway.

D. Provide all wiring and connections to the elevator switch panel for power, fire safety control heat detectors, voltage monitoring, fire alarm and anti-power outage entrapment (A.P.E.).

E. Provide labels to identify the anti-power outage entrapment (A.P.E.) circuit and conduit.

END OF SECTION 26 28 20

SECTION 26 2913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 MOTOR CONTROLS AND EQUIPMENT CONNECTIONS

A. Scope: Provide all line voltage wiring and connections to equipment and motors as shown on the plans, diagrams or specified herein. Prior to rough-in Contractor shall obtain all necessary electrical and physical information from the trade providing the equipment and adjust installation requirements as necessary for a complete and operable system.

B. Motor Controls, Separately Mounted: Provide separately mounted motor starting equipment as shown or noted. Coordinate location and interlocking with Temperature Controls Contractor. Verify motor horsepower size or full-load amperage prior to ordering overload heaters, and size units in accordance with the National Electrical Code.

1.2 OWNER-FURNISHED EQUIPMENT

A. Provide complete electrical service and connection to all Owner-furnished equipment as shown on the drawings or herein specified, unless indicated otherwise.

1.3 ELEVATOR WIRING

A. Scope: Provide all line voltage wiring and automatic disconnecting means to elevator equipment as shown on the drawings and as specified herein.

B. Pit Lighting and Power: Provide light fixture, receptacle and light switch in pit as shown on the drawings.

C. Elevator Disconnect: Provide surface-mounted elevator fused disconnect switch located as shown on the drawings.

1.4 KITCHEN WIRING

A. Scope: Provide all wiring for kitchen equipment; connect all equipment; assist the Food Service Equipment Contractor in the testing of equipment after connection.

B. Coordination: The Electrical Contractor shall coordinate with the Food Service Equipment Contractor to ensure that each item of equipment which requires electrical service is properly connected and wired.

C. Equipment Wiring: In general, the Food Service Equipment Contractor shall furnish electrical devices and control equipment which are an integral part of the kitchen equipment and will connect all such equipment wiring brought to a single connection point. Electrical control equipment, which is not an integral part of the equipment, will be furnished by the Food Service Equipment Contractor to the Electrical Contractor for mounting and connection, except as noted on drawings. The Electrical Contractor shall provide service connections to each item of equipment; shall mount and connect all control equipment not an integral part of the equipment. The location and method of wiring of control devices shall be ascertained prior to installation.

D. Conduit Roughing-In: Suit the equipment finally approved for installation and conform to the latest approved shop drawings. All wall-mounted devices shall be flush type.

E. Exposed Work: All exposed conduits, enclosures and fittings shall be galvanized except for watertight flexible conduit connections.

F. Connections from Floor: Provide 6' long galvanized rigid conduit screwed into a flush coupling with watertight flexible conduit connection from coupling to the connection point on each piece of equipment. Provide finish type chrome plated escutcheon ring a floor. All connections at floor shall be watertight.

G. Connections from Wall: Watertight flexible conduit between stainless steel cover plate on outlet box and piece of equipment.

H. Disconnect Switches: Provide for each piece of equipment as required by code. Disconnect switches shall be placed wherever possible within the equipment at the point of connection. Where this is not practical, the location of the disconnect shall be verified with the Architect. Disconnects shall be molded case circuit breaker. Where mounted on the wall, they shall be flush with chrome plated face plate.

I. Hood lights: Furnished with hood. Provide conduits connection to the hood light connection point.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Motor starters shall be Eaton, Siemens, ABB, or Square D.

2.2 MOTOR CONTROLS

A. Unless noted otherwise, all starters shall include Phase loss and phase unbalance protection.

B. Manual Starters: Toggle type, with overload protection, NEMA 1 enclosure. Square D Class 2510.

C. Magnetic Starters: Full voltage, non-reversing, or multi-speed where shown, NEMA 1 (minimum), 3-leg overload protection, 120-volt control, transformer, hand-off-auto switch, red and green indicating lights, 2-N.O. and 2-N.C. auxiliary contacts, Square D Class 8536 Series. Motors 5 HP and larger provide a phase failure/undervoltage relay.

D. Combination Starters: Full voltage, non-reversing as specified above with integral fused disconnect.

E. Variable Frequency Drives
   1. Motor starters shall be ABB. Substitutions may be considered when submitted in conformance with Section 26 05 00.
   2. See Division 23 for complete requirements.

F. Provide all required relays, wiring, and miscellaneous equipment for Fire Alarm Fan Shutdown compliant with applicable fires codes in conjunction with the site's Energy Management System (EMS). Interconnecting controls shall be rated to match starter control voltage.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Provide shutdown for HVAC equipment through the site's EMS system.

3.2 ISOLATION

A. All rotating and air handling equipment shall be connected with flexible conduit to provide sound and vibration isolation.

3.3 TESTING

A. After all wiring to each unit is complete, Electrical Contractor shall cooperate with Mechanical Contractor in testing equipment for proper operation and shall correct wiring as required for proper operation. All connections shall be checked with a torque wrench. Torque levels shall be in accordance with NETA Standard ATS unless otherwise specified by the manufacturer. A test report which gives the following information for each motor shall be submitted to the Engineer two weeks prior to final inspection:
   1. All nameplate data (voltage, phase, full load current, locked motor current, NEMA design, code letter, RPM, etc.)
   2. Measured no-load voltage at motor terminals (all phases).

3. Measured full-load voltage at motor terminals (all phases).
4. Full load operating current (all phases).
5. Motor starter manufacturer and overload heater number (attach the manufacture's table of overload heater numbers and corresponding motor nameplate ranges).
6. Fuse size and type.
7. Motor phase-to-phase and phase-to-ground winding resistance (motors 5-HP and larger).

B. A copy of the test report shall be included in the Commissioning Field Notebook and the Operations and Maintenance Manuals.

END OF SECTION 26 29 13

SECTION 26 2933 - MECHANICALLY HELD CONTACTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specification sections and all Division 26 sections apply to this section.

1.2 SUMMARY

A. Section includes mechanically held contactors for control interlocking the kiln power and exhaust.

1.3 SUBMITTALS

A. Product Data: Indicating number of poles, contact rating, ampere rating, control accessories, enclosure dimensions and ratings.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Contactors shall be of the number of poles and ratings as indicated.

B. Contactors rated 60 amps or greater shall be equal to Asco #920 mechanically held type.

C. Two-wire control accessory: All contactors shall be equipped with two-wire control accessory 47. All contactors shall be furnished with coil clearing contacts that de-energize the coil immediately after an operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Contactors shall be installed in steel cabinets. Cabinets located adjacent to or below a panelboard shall match the panel in size, shape and appearance. The cabinets shall have covers which match the panelboard and be keyed alike.

B. Contactor control shall be for remote manual operation by switch as indicated.

END OF SECTION 26 29 33

SECTION 26 5100 - LIGHTING FIXTURES

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Drawings and general provisions of this Contract, including General and Supplementary Conditions and Division 1 specifications, apply to work specified in this section.

B. Related Sections:

Section 26 0100 – Electrical Requirements: Product substitution procedures
Section 26 0526 – Grounding & Bonding: Requirements for bonding
Section 26 0529 – Hangers and Supports: Luminaire support requirements
Section 26 0531 – Outlet Boxes: Outlet boxes for use with certain luminaires
Section 26 0923 – Distributed Lighting Controls

1.2 SUMMARY

A. This section includes the following:
1. Interior & Exterior luminaires
2. Emergency lighting and exit signs
3. Lighting poles
4. LED light engines, arrays, modules
5. LED drivers

B. Luminaires shall be complete with trim, mounting hardware, drivers and LED light engines. Fixtures shall be suitable for the location in which they are installed.

C. Provide all materials required to entirely complete each luminaire ready for use, in accordance with the conditions and requirements of the building construction.

1.3 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C2, "National Electrical Safety Code."

E. Comply with NFPA 70.

1.4 WARRANTY

A. Luminaires, poles, mounting components, LED light engines: Provide the standard manufacturer’s warranty; minimum one-year for all material and labor, for all lighting fixtures provided in this contract.

B. In addition to the warranty specified in the General Conditions, each manufacturer of electronic lighting components shall warranty the electronic LED drivers to be free from defects in materials and workmanship. This additional warranty shall extend for a period of at least five (5) years from the date of substantial completion for the Project. The warranty shall cover the full cost of repairing all the components or furnishing replacements in kind. The warranty shall not be pro-rated and there

shall be no deductible amount. Include warranty certificate in the Operating and Maintenance Manuals.

1.5 SUBMITTALS

A. Product Data: Specific product data shall be provided for each type of interior and exterior luminaire and include light pole, bases, driver, LED module, lumens, wattage, distribution, mounting, materials, finishes, dimensions, weights, accessories, photometry and efficiency data. Shop Drawings: Outline drawings and fabrication details for each custom-fabricated luminaire type provided on the Project, indicating dimensions, weights, methods of field assembly, components, features, and accessories. Wiring diagrams for “master/slave” tandem wired luminaires.

1.6 INFORMATION FOR OPERATING & MAINTENANCE MANUALS

A. Submittals: Information submitted for review, up-dated to record any changes.

B. Maintenance Instructions: List replacement parts, including source. Indicate recommended and required maintenance and testing procedures and intervals. List all individual lighting components that require periodic maintenance. Identify features, accessory attachments, safety precautions, and procedures for cleaning, LED module and driver replacement.

C. Warranty: Component manufacturers’ warranty certificates.

PART 2 - PRODUCTS

2.1 LUMINAIRES

A. See schedule on Drawings for listing of required luminaires. Luminaires shall be complete with trim and mounting hardware. Provide hardware for each luminaire based on the ceiling condition for which it is to be installed.

B. All LED systems provided shall be tested in accordance with IES LM-79 and LM-80.

C. All luminaires shall bear the UL label associated with the type, location, ambient temperature and usage of the individual luminaire.

D. Luminaires with replaceable LED drivers shall be completely enclosed in and shall not require removing the luminaire from its mounting to access the driver. Integral LED drivers shall be installed by the manufacturer and supplied as a total system with the fixture housing and LED modules/boards.

E. Where specified; Custom colors shall be applied to luminaires as indicated on the luminaire schedule. Custom colors shall match color samples supplied by the Architect.

F. Luminaires equipped with doors shall be free of light leakage around the doors under normal operating conditions. Doors shall be designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in the normal operating position. Doors shall utilize spring-loaded latches on fluorescent troffers and on other luminaires that are available with such an option.

G. All plastic lenses shall be UV-stabilized virgin acrylic unless otherwise indicated. Flat plastic lenses shall be KSH-12 or equal and a minimum of 0.125 in thick. Prisms shall be square cut at 45°; round cut is not acceptable.

H. All Alzak finished louvers and reflectors shall be low iridescent type. All louvered luminaires shall be shipped with dust covers. Covers shall be removed after final building vacuuming has been completed.

I. Exit signs shall be internally-illuminated. Illumination of lettering on each sign shall be diffuse, with a minimum luminance of 8.6 candela/m² (2.5 foot-lambert).

J. Wire Guards: Where luminaires are indicated to be protected by wire guards, provide removable wire guards that are standard products of the luminaire manufacturer and that fit the luminaires to

be protected. Wire guards for exit signs and other wall-mounted luminaires shall secure to the wall and shall not be attached to the luminaire itself.

K. Luminaires are to be coordinated with the lighting control system and supplied with all necessary components to produce a fully functional system. Components may vary based on the lighting control approach of the relevant manufacturers. The lighting control manufacturer components may be provided integral to the lighting fixtures. Integral control components is optional and dependent upon the manufacturer. The contractor shall verify whether or not control components are integral or external and adjust their bid to include any extra associated work. See section 26 0923 – Lighting Control Devices.

2.2 LED DRIVERS

A. Comply with ANSI, NEMA, IESNA & UL standards for LED drivers.

B. Each luminaire shall be provided with a LED driver, suitable for operation of the light engines. LED driver voltage rating shall be universal or as specified to match circuit voltage.

C. LED Drivers: LED drivers to operate with a drive current in the range of 300mA and 1000mA as indicated by specification information in the luminaire schedule. Each driver to be tested with LED module for which it is installed per IESNA LM-79 and LM-80 certification standards. LED drivers to be supplied by luminaire manufacturer and supplied with the fixture as a tested and certified system.
   1. LED drivers shall be available for voltages listed on drawings.
   2. LED drivers shall be provided with multi-level control where indicated on drawings
   3. LED luminaires indicated as emergency lights on drawings shall be compatible with emergency battery packs that support LED, to be provided by the fixture manufacturer.

D. Drivers shall be potted and equipped with heat sinks for thermal dissipation.

E. Power factor: greater than 0.9%.

F. Dimming drivers: 0-10V, 1%.

G. Exterior drivers: Ambient temperature range: -22º to 104º F. Surge suppression: Module with 10KV transient voltage surge suppression.

H. Drivers shall be completely enclosed in wiring channels arranged to permit easy access. Ballast/Driver replacement shall not require removing the luminaire from its mounting.

2.3 LIGHT-EMITTING DIODE (LED)

A. Comply with ANSI, NEMA, IESNA & UL standards for LED array.

B. Interior LEDs: Rated life of 60,000 hours minimum, at 85% lumen output (minimum).

C. Exterior LEDs: Rated life of 50,000 hours minimum, at 85% lumen output (minimum).

D. LED to be driven at nominal drive current for the specified output (300mA-1000mA range) and tested with LED driver as a complete system for which it is installed per IESNA LM-79 and LM-80 certification standards.

E. LED color temperature and binning to be within a 3-step MacAdam ellipse.

2.4 LIGHT POLES

A. Structural Characteristics: Comply with AASHTO LTS-4.
   1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
   2. Retain subparagraph below to help ensure that poles are stiff enough to avoid excessive flexure and vibration. Alternatively, add requirements for minimum pole wall thickness and other parameters. See Editing Instruction No. 6 in the Evaluations.

3. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet (12 m) in height with access handhole in pole wall. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Poles shall be equipped with internal cable supports and a hand-hole with cover located near the base. Poles shall also include anchor bolts, base covers and all luminaire mounting hardware.

D. Pole finish shall be factory applied.

E. Poles shall be designed to withstand continuous wind velocities up to 90 miles/hour and gusts up 130% of rated velocity while supporting the quantity and types of luminaires indicated on the luminaire schedule.

F. Designated poles with video surveillance cameras shall be provided with factory grommet holes for mounting cameras and media converter boxes.

G. Base covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

2.5 LIGHTING FIXTURE SUPPORT

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge (2.68 mm).

E. Coordinate first paragraph below with Drawings to identify humid spaces.

F. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge (2.68 mm).

G. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

2.6 SPARE MATERIALS

A. Furnish spare materials in the following quantities:
   1. LED drivers: 2% of each fixture types listed below not to exceed 5 spare drivers/type.
      a. H.A1
      b. H.A2
      c. H.C1
      d. H.D1-7
      e. H.F1-8
      f. H.F1R
      g. H.G3
      h. H.J1
      i. H.K1
      j. H.P1
      k. H.Q1
      l. R.A1
      m. R.B1
      n. R.C1
      o. R.F1
      p. R.H1-8

q. R.K1
r. R.L1-3
s. S.A1
t. S.B1
u. S.C1
v. S.G1
w. T.A1
x. W.C1-3
y. W.F1E
z. W.G1
aa. W.H1
bb. W.K1
cc. W.M1

B. Percent quantities shall be calculated by rounding up to the next whole number.

PART 3 - EXECUTION

3.1 INTERIOR LIGHT FIXTURE INSTALLATION

A. Install luminaires in accordance with the manufacturer's recommendations and installation details.

B. Provide backboxes matched to luminaires. Where luminaires are suspended from ceiling grids, provide special interface outlet boxes designed to mount on grid members and facilitate power cable interface at the suspension point canopy, such that the power cable neither lies exposed above the ceiling nor runs in raceway. In other locations, where luminaire manufacturer's installation instructions indicate use of standard outlet boxes, boxes shall be in accordance with Section 26 0531. Back boxes shall be plumb and perfectly aligned.

C. Installation shall be coordinated between ceiling, mechanical, plumbing, fire protection and other contractors before installation or rough-in to prevent interference with other equipment and devices to ensure the fixtures can be installed as indicated.

D. Mount interior luminaires at locations indicated on the drawings. Support luminaires in accordance with Section 26 0529, in the following manner:
   1. Mount suspended stem supported luminaires on swivel hangers where required which are a standard catalog item of the same manufacture as the luminaire. Support from fixture stud, or as otherwise recommended by the manufacturer. For linear luminaires, provide one more hanger than the number of luminaires in the row. Coordinate degree of swivel with the ceiling slope. Other suspension methods may be considered in mechanical type rooms where approved by Architect's Consultant.
   2. Mount suspended aircraft cable supported luminaires on canopies which are a standard catalog item of the same manufacture as the luminaire. Support from ceiling grid where applicable, or as otherwise recommended by the manufacturer. For linear luminaires, provide one more hanger than the number of luminaires in the row.
   3. Mount suspended chain supported luminaires on hangers which are a catalog item of the same manufacture as the luminaire. Support from building structure as recommended by the manufacturer. For linear luminaires, provide one more hanger than the number of luminaires in the row.
   4. Mount surface and wall luminaires square with the room. Support from fixture stud or as otherwise recommended by the manufacturer. Attach surface luminaires at two (2) support points, minimum. Provide 38mm (1½ in) metal spacers for luminaires which occur on combustible ceilings. Submit spacer for approval.
   5. Install recessed luminaries in suspended acoustical ceiling systems in accordance with the provisions of ASTM C636. Verify all ceiling types and ceiling thicknesses to ensure that recessed luminaires can be properly installed. Provide plaster frame mounting kits where recessed luminaires are to be installed in hard ceilings.

E. Verify all measurements. Luminaires must fit in place in a regular, trim and workmanlike manner, to the satisfaction of the Architect's Consultant. Verify the type of ceiling system in every room or space to ensure that the luminaires are compatible before releasing orders for luminaires. Incorrectly ordered luminaires shall be replaced, with no additional compensation.

F. Verify luminaire locations with the Architectural reflected ceiling plans and interior wall elevations.

G. All recessed luminaires installed in accessible ceilings shall be connected by means of a flexible raceway or fixture whip which is attached to a 100 mm (4 in) square junction box. Box may serve more than one luminaire.

H. Provide bonding connections in accordance with Section 26 0526 and manufacturer's installation instructions.

I. After installation, all visible labels shall be removed from luminaires.

J. Immediately prior to occupancy, clean reflectors, aperture plates, lenses, louvers, luminaire housings and decorative elements. To prevent static buildup on lenses and reflectors, clean with a manufacturer's recommended water-diluted solution of glass cleaner and allow to air-dry after installation.

K. Broken or defective parts shall be replaced, with no additional compensation.

L. All fingerprints, dust and other substances shall be removed from louvers before final acceptance by owner. Clean louvers per the manufacturer's instructions.

3.2 EXTERIOR LIGHT FIXTURE INSTALLATION

A. Install luminaires in accordance with the manufacturer's recommendations and installation details.

B. Provide backboxes matched to exterior wall mounted luminaires. Where luminaire manufacturer's installation instructions indicate use of standard outlet boxes, boxes shall be in accordance with Section 26 05 33. Back boxes shall be plumb and perfectly aligned.

C. Mount exterior luminaires at locations indicated on the drawings in the following manner:
   1. Mount pole-top luminaires on light poles matched to the luminaire. Mounting provisions shall provide structural integrity to withstand the specified wind loading, while maintaining an integrated appearance, coordinated with both the luminaire and the pole.
   2. Mount surface and wall luminaires square with the building lines. Support from fixture stud or as otherwise recommended by the manufacturer. Attach surface luminaires at two (2) support points, minimum.
   3. Install recessed luminaries in exterior soffits in accordance such that luminaire weight is supported by structural members. Verify soffit material and thickness to ensure that recessed luminaires can be properly installed.

D. Site lighting pole locations shown on the electrical site plan are approximate. Coordinate site lighting locations with the Architectural, Civil and Landscape site plans and contractors. Coordinate building mounted fixtures with exterior wall elevations.

E. Mount lighting poles on reinforced concrete bases as indicated on the Drawings. Position anchor bolts so that luminaires will be aligned with the appropriate surface features, as indicated. Level each anchor bolt plate so that the associated lighting pole will be vertical and plumb. Provide grout between the concrete base and anchor bolt plate to eliminate gaps. Pole bases may be cast-in-place or pre-cast per the base details.

F. Provide bonding connections between the pole and the reinforcing steel in the concrete base in accordance with Section 26 0526 and manufacturer's installation instructions.

G. Broken or defective parts shall be replaced, with no additional compensation. Damaged finishes to poles, fixtures or bases shall be repaired to the owner's, architect's or engineer's satisfaction. Failure to restore the material to factory-like finish may result in replacement of damaged product.

3.3 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
   2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
   3. Trees: 15 feet (5 m).

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.
   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
   3. Install base covers, unless otherwise indicated.
   4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
   1. Dig holes large enough to permit use of tampers in the full depth of hole.
   2. Backfill in 6-inch (150-mm) layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

F. Embedded Poles with Concrete Backfill: Set poles in augured holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
   1. Make holes 6 inches (150 mm) in diameter larger than pole diameter.
   2. Fill augured hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20 MPa) at 28 days, and finish in a dome above finished grade.
   3. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
   4. Cure concrete a minimum of 72 hours before performing work on pole.

G. Raise and set poles using web fabric slings (not chain or cable).

3.4 ADJUSTMENT & TESTING

A. Notify the Owner’s Representative at least two (2) weeks in advance of the date of each test, to allow witnessing of the tests.

B. Supply tools, instruments, gauges, testing equipment, protective devices and safety equipment for adjustment and testing, and demonstration.

C. During adjustment and testing, carefully record all settings and all test results, including expected test results, actual test results, and corrective actions taken. Records shall be submitted to the Architect's Consultant and included in the Operating & Maintenance Manuals.

D. Upon completion of the installation, aim all adjustable luminaires as directed by the Architect’s Consultant. After adjustments are complete, measure the illumination levels at selected points to demonstrate proper distribution and coverage. Verify with the Architect’s Consultant the points where illumination levels are to be measured.

E. Test emergency egress lights and exit fixtures to confirm 90 minutes of operation on battery power.

F. Correct any deficiencies discovered as a result of the above testing, and completely retest the work affected by such corrections, with no additional compensation.

END OF SECTION 26 51 00

DIVISION 27 – TELECOMMUNICATIONS

SECTION 27 0010 - GENERAL PROVISIONS FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the contract, including General and Supplementary Conditions, Division 01 Specification sections, apply to this section.

1.2 SUMMARY

A. Section includes:
   1. Definitions and abbreviations
   2. Contract documents
   3. Code requirements
   4. Permits & fees
   5. Alternates
   6. Submittal requirements
   7. Prior approval requests
   8. Schedule of Values
   9. Warranty
   10. Construction phasing
   11. Project closeout requirements

1.3 DEFINITIONS

ADA	Americans With Disabilities Act
Ampacity	Capacity expressed in amperes
ASTM	American Society for Testing & Materials
Concealed	Hidden from sight as in trench, chases, slabs, furred spaces or ceilings
Contractor	Shall mean the General Contractor who signs the contract with the Owner
EMT	Electrical Metallic Tubing
Exposed	'Not concealed' as defined above
Furnish	Supply
IBC	International Building Code
IFC	International Fire Code
IEEE	Institute of Electrical & Electronic Engineers
IPCEA	Insulated Power Cable Engineers Association
Indicated	Indicated on drawings
Install	Install or apply
Mfg.	Manufacturer
NBFU	National Board of Fire Underwriters Pub. 70 (latest edition)
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Testing Lab
Provide	Furnish and install
UL	Underwriters Laboratories, Inc.
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety Health Act

1.3 GENERAL SCOPE OF WORK

A. It is the intention of the Division 27 Contract Documents to provide complete and fully operational limited energy systems for telecommunications cabling, audio/visual, sound reinforcement,

intercom, master clock and communications hereinafter specified and/or as shown on the drawings. The work shall include all materials, appliances and apparatus not specifically mentioned herein or noted on the plans, but which are necessary to make a complete working installation.

B. Reference the Technology system matrix at the end of Division 28 for owner provided materials.

1.4 CONTRACT DOCUMENTS

A. All limited energy systems, mounting hardware, labor and other items indicated on the Division 27 drawings, schedules and/or in the specifications shall be included in the Contractor's bid, unless specifically indicated otherwise. The specifications, schedules, diagrams, details, and plans are complementary and what is indicated on any is as binding as if indicated on all. Where a conflict exists between what is shown and what is specified, the more stringent shall govern.

B. The contract drawings indicate the extent and the general character and approximate location and arrangement of material and equipment. The documents do not necessarily show the total number of conductors, raceways, boxes, support, access panels, actual routing, block outs, cable sleeves, exact device or equipment locations or other such detailed information for the work required. The Contractor shall provide all necessary materials as required by applicable code and product specification for a complete and fully operational installation in accordance with the true intent of the drawings and specifications.

C. All dimensions indicated in the Division 27 drawings are approximate and are indicated as a guideline only. The Contractor shall adjust the exact rough-in locations as necessary to avoid conflict with structural components or other materials and to assure that devices, boxes, etc., can be installed as close to the intended location as possible. Working measurements shall be taken from the building and checked with the Architectural and Structural drawings. If conflicts are found the Contractor shall request verification from the Architect before proceeding with that work.

D. The Division 27 documents do not separate work or responsibilities of sub-contractors. The General Contractor is responsible for defining the scope of work of each contractor. This specification recognizes only one contractor. That is the General Contractor who signs the contract with the Owner. Where the term 'The Contractor' is used, it applies to the contractor responsible for the installation of the work described.

1.5 CODES

A. The installation of this work shall comply in every way with the requirements of the laws, ordinances and rules of the State of Washington, the National Board of Fire Underwriters, the National Electrical Code, WISHA and the City of Pasco, WA.

B. If any conflict occurs between these rules and this specification, the rules shall govern. Nothing in these drawings and specifications shall be construed to permit work not conforming with governing codes. This shall not be construed as relieving the Contractor from complying with any requirements of the plans or specifications which may be in excess of requirements of hereinbefore mentioned rules and not contrary to same.

1.6 PERMITS & FEES

A. Obtain and pay for all licenses, permits, registration fees and inspections required by laws, ordinances and rules governing the work specified herein. Arrange for inspection of the work by inspectors and give the inspectors all necessary assistance in their work of inspection.

B. The Division 27 bid shall include all Labor and Industries permit, inspection, licensing, registration, or any other fees associated with the work specified under this Division.

1.7 SUBMITTALS

A. It is understood that before the manufacture or installation of any of the work under this contract is carried forward, shop drawings of such work shall be submitted for review.

B. Submittals shall be provided in accordance with specification Section 26 0010.

C. The Contractor shall provide quantities of submittals and shop drawings as required by Division 01. The Owner, Architect and Electrical Engineer will retain a minimum of one digital set each.

D. Shop drawings shall be submitted in ample time to avoid delay in any of the work. Items requiring immediate attention due to long lead delivery time or for early construction rough-in, are to be identified and may be submitted separately in advance of the remainder of the submittal binders. The review of these items will be expedited.

E. The Architect and Engineer's review of the submittals/shop drawings is intended as a check for general conformance with contract documents only. Failure by the Architect or Engineer to discover an error on a submittal does not relieve the Contractor of the responsibility for compliance with requirements of the drawings and specifications.

F. Upon request from the Architect or Engineer, provide material samples for examination, color selection and/or quality control. These samples shall be delivered to the Architect's or Engineer's office as directed.

G. Prior to forwarding to the Architect, the Contractor shall review the submittals, mark them with their comments, corrections, and approval stamp. The Contractor shall verify that all of the specified requirements are indicated and ensure that the intended items have been identified on the submittal. Submittals shall be clearly marked as to which items, options, colors, models, etc. are being provided. Only the items marked or indicated will be considered as being submitted. If no marks or indications are present on a page, then it will be assumed that nothing applies to this project and the submittal will be rejected. Indicate additional information necessary for the Architect and Engineer to determine the Contractor's intention, such as the method of feeding panelboards (top or bottom), color selection, equipment options, etc.

H. For material requiring color or finish selection 'by Architect', provide separate copies marked 'ATTENTION (ARCHITECTS NAME) – COLOR/FINISH SELECTION REQUIRED'.

I. Provide brochures and shop drawings on the following materials:
   1. Extra voice/data receptacle log with fair cost estimate
   2. Intercom/Clock System
   3. Audio/Visual Systems
   4. Sound Reinforcing Systems
   5. Premise Wiring:
      a. Certification of Contractor
      b. Cable
      c. Jacks
      d. Cable support devices
      e. Patch Panels
      f. Racks
      g. Wire Management
      h. Fiber Optic Cable, Connectors, etc.

1.8 PRIOR APPROVAL SUBSTITUTION REQUEST

A. Items specified are basis-of design and intended to represent quality and general requirements. It is not the intent of these specifications to prohibit other manufacturers from submitting on substitute materials for review as an acceptable equal. Approval granted for substitution requests is made under the assurance that the manufacturer, vendor, or sales representative guarantees that the substituted product meets or exceeds the minimum requirements of the specified product.

B. To ensure ample time for review, evaluation, and publishing (by addendum), substitution requests must be submitted no later than ten normal business days prior to the bid. Submittals received less than ten normal business days will be at risk of not being published and allowed to bid.

C. Vendors seeking prior approval shall include system certifications in their submittal.

D. If prior approval has not been requested and granted, then the product manufacturer shall be as specified in the contract documents. The Architect/Electrical Engineer reserves the right to reject any product that has not been prior approved or specified.

E. The Contractor shall be responsible for checking equipment dimensions of proposed substitute equipment and be responsible for it fitting the space allowed.

F. Approval of substitution requests are granted with the understanding that any additional cost involved with the installation, re-design or replacement of the substituted material (as a result of the unacceptable performance of that product) shall be paid for by the Contractor.

G. Approved substitutions will be listed in Addenda. Any item listed by addenda may be provided under this contract.

H. Substitution after the bid will only be allowed for any one of the following reasons:
   1. The Architect, Engineer and Owner approve the substitute product as a better product, at no increased cost.
   2. The substitute product is approved as an equal by the Architect, Engineer and Owner and a credit is offered to the Owner. Reference Division-1 documents for substitution request procedures.
   3. The reason for unavailability is discontinuance by the manufacturer.

1.9 SCHEDULE OF VALUES

A. Within 30 days of the Notice to Proceed the Contractor shall furnish a breakdown of the Division 27 work as indicated in the following Schedule of Values:
   1. Mobilization
   2. Closeout
   3. Intercom/Clock, Material
   4. Intercom/Clock, Labor
   5. Telecommunications Wiring, Material
   6. Telecommunications Wiring, labor
   7. A/V, Material
   8. A/V, labor
   9. Sound System, Material
   10. Sound System, Labor

1.10 GUARANTEE

A. This Contractor shall guarantee the satisfactory operation of all material, equipment and installations provided under this specification. Make good, repair or replace, as may be necessary, any defective work, materials or equipment which fail or become defective within one year after date of Owner occupancy. The beginning of the warranty period is to be determined by the Architect at the time of substantial completion.

B. Provide extended warranty for the voice/data communications cable backbone (Premise Wiring) system: fifteen years (material and labor).

PART 2 - PRODUCTS

2.1 GENERAL MATERIAL EQUIPMENTS

A. All materials shall be new and must be equal to the quality herein specified and as shown on the drawings or a reviewed and accepted equal.

B. Reference the Technology Component System Matrix following the Division 28 specifications for an outline of materials that are CFCI, OFCI & OFOI.

C. All materials shall be the standard products of manufacturers regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design and shall be manufactured in accordance with applicable standards of NEMA, ANSI or UL.

D. Provide the materials specified unless a product has been discontinued or revised in which case provide the manufacturer's equivalent product replacement.

E. All material, equipment and devices shall be listed by Underwriters Laboratories, Inc. and shall be manufactured for use with the system specified and the intended application.

F. Materials and equipment shall be delivered to the project and stored in original containers or cartons and shall be properly protected from the elements, theft or vandalism. Items subject to moisture damage shall be stored in dry spaces.

G. Material damaged during construction shall be replaced or repaired to the Owner's satisfaction.

H. All material shall be provided and installed per the requirements for seismic zone D.

I. All cabling provided under Division 27 shall be rated for the location installed. Cabling installed in wet locations shall be rated for such and installed in conduit the entire run. Provide metallic enclosures to splice from outside plant to riser cable in accordance with the Washington State Administrative Code.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS FOR INSTALLATION

A. Workmanship shall be of the best quality and none, but competent mechanics shall be employed and shall be under the supervision of a competent foreman. All work shall be complete and present a neat and symmetrical appearance. Non-professional workmanship shall be removed and replaced if so, directed by the Architect at no additional cost to the Owner.

B. All equipment and material shall be installed to comply with all applicable codes and industry standard work practice.

C. All work and materials shall be subject to inspections at any and all times by representatives of the Owner and/or Architect.

D. The documents do not show all necessary transitions, offsets, changes in direction or every pull or junction box required. Provide all boxes necessary to install work to conform to the structure.

3.2 WORK NOT INCLUDED

A. Unless noted elsewhere, the following is owner furnished owner installed:
   1. VOIP Telephone headend (existing district wide system).
   2. Computer station patch cords.
   3. Telephone handsets and patch cords.
   4. Network Equipment; servers, switches
   5. Video projectors / Screens
   6. Software and licensing

3.3 PHASING & SCHEDULING REQUIREMENTS

A. Construction phasing and scheduling unless specifically indicated elsewhere in the bid documents is the responsibility of the General Contractor. The Electrical and Communications trades shall coordinate their work with the General Contractor.

3.4 MEETINGS AND FIELD OBSERVATION

A. A representative of the Electrical Consultant shall attend monthly construction coordination meetings and conduct an observational walk-through.

B. At the time of monthly walk-through, the project foreman shall (upon request) accompany the observation party, and remove cover plates, panel covers, ceiling tiles, access panels and unlock doors for the Electrical Consultant, to allow complete observation of the entire electrical system in an efficient manner.

C. The Contractor shall provide all ladders, tools, and hard hats required by the Electrical Consultant. The Contractor shall open any switchboard, panel, box, etc. as requested for the Architect/Engineer's inspection.

D. The Contractor shall bring the red-line (mark-up) set of Record Drawings to each monthly meeting attended by the Electrical Consultant for review.

3.5 UTILITIES

A. It shall be the contractor's responsibility to coordinate and confirm all aspects of the utility service. work to the building with the serving utility companies listed below. The contractor shall verify the requirements indicated on the documents are accurate and meet all utility requirements prior to beginning any utility work.

B. The serving utility companies are as follows:
   1. Fiber: Franklin PUD; 509/547-5591, Brent Weatherman or Ben Hooper
   2. Telephone: Century Link; 509-305-7503, Tobias Mears

3.6 PROJECT CLOSEOUT

A. Prior to final acceptance of the project the Contractor shall provide Division 27 record drawings and operation and maintenance manuals (O&M) for all work included in this contract

B. Submittals, record drawings, O&M manuals and deliverables shall be provided in accordance with specification Section 26 0010.

C. The Contractor shall leave the job in complete order ready for use. All refuse shall be removed, all devices and equipment shall be secure, fully equipped, completely cleaned and in good working order. The owner's maintenance & operational personnel shall be thoroughly indoctrinated in the maintenance & operation of each system provided under this division. All spare and remaining items not used in the project but paid for by the owner shall be delivered in like new condition to an on-site storage facility as directed by the owner.

END OF SECTION 27 00 10

SECTION 27 0500 - COMON WORK RESULTS FOR COMMUNICATIONS

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Communications equipment coordination and installation.
   2. Sleeves for pathways and cables.
   3. Sleeve seals.
   4. Grout.
   5. Common communications installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So that connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

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

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR PATHWAYS AND CABLES

A. Provide sleeves in accordance with the requirements of specification Section 260500.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter, less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter, equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange, and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications' equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. All material and equipment shall be installed symmetrical, level, plumb, parallel, and perpendicular to other building systems and components, except where otherwise indicated.

G. Devices shall be mounted in compliance with the Americans with Disabilities Act (ADA) or as specified within the limits described below.
   1. High forward reach limits, without obstruction; between 15" and 48".
   2. High forward reach limits, with obstruction less than 20"; between top of obstruction and 48".
   3. High forward reach limits, with obstruction between 20" & 25"; between top of obstruction and 44".
   4. Clear floor space, parallel approach; between 9" and 54".
   5. Side reach over a 24" wide by 34" maximum obstruction; 46".

3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways or cables penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.3 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 27 05 00

SECTION 27 1500 – TELECOMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This section is a Division-27 Basic Electrical Materials and Methods section and is part of each Division-27 section.

B. Drawings and General Provisions of the contract, including General and Supplementary Conditions, Division-1 Specification sections and all Division-26 & 27 sections, apply to this section.

1.2 DESCRIPTION OF WORK

A. Reference the Technology Component System Matrix following the Division 28 specifications for an outline of materials that are CFCI, OFCI & OFOI.

B. Provide all labor, materials, tools, equipment and services for a complete TIA/EIA 568, Riser Rated Category 6, local area network (LAN) Telecommunications transmission cable systems installation.

C. Provide all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a secure and complete installation whether or not specifically indicated in the contract documents.

D. Systems requiring telecommunications cable as specified in this section include data network, VOIP telephone, Audio/Visual systems, Video Surveillance, Access Control, IP Clock, IP Intercom, and site readerboard.

E. Each jack cable shall run to the closest TR (MDF, IDF-1, or IDF-2) as appropriate in a star topology from each room.

F. Provide Telecommunications Room (TR) backbone cabling consisting of multi-mode fiber optic cable between the MDF and each IDF.

G. Contractor Furnished Contractor Installed (CFCI) materials:
   1. Category 6 UTP horizontal cable
   2. Multimode optical fiber
   3. Copper backbone cable
   4. Workstation outlet, devices, jacks & plates
   5. Network and communications connections & devices for A/V, IP camera, IP clocks, IP speakers, DDCS, Access Control, Intrusion, Networked Lighting Control and FA systems
   6. CAT 6 patch cords for IP cameras
   7. Device rough-in
   8. Open cable support hooks
   9. Equipment racks with Ladder tray, patch panels, horizontal & vertical cable management, equipment shelving, optical fiber patching, optic cable connectors, accessories and miscellaneous rack hardware & components
   10. Fire treated backboards
   11. Labeling and identification
   12. Grounding and bonding
   13. Outside plant conduit for installation of utility optic fiber and telephone cabling
   14. Fire stopping for all IT pathways
   15. Provide labor, instrumentation, and documentation for O&M manuals for permanent link testing of all terminated cables in the structured cabling system.
   16. Power Distribution Units (PDU) for IT racks
   17. Uninterruptable Power Supplies (UPS) for IT 4-post racks.

H. Owner Furnished Contractor Installed (OFCI) equipment:
   1. Wireless Access Points (WAP)

I. Owner Furnished Owner Installed (OFOI) equipment:
   1. Network servers
   2. Network switches
   3. Network programming & QOS scheduling
   4. Network licensing
   5. Network software (except where specified in other Division 27 sections)
   6. CAT 6 patch cords for workstations and patch panels

1.3 SUBMITTALS

A. Pasco School District has standardized on a unified, end-to-end copper and optical fiber cabling system design based on Leviton jacks, patch panels, patch cords, fiber cords, fiber connectors, trunk cables, fiber enclosures and modules, as well as Berk-Tek field-terminable copper and fiber cables. Pasco School District is satisfied that the products specified herein are qualified for the purpose intended and has performed due diligence in establishing a consistent set of standards based on performance and feature set.

B. Pre-construction submittal:
   1. Provide a complete submittal of all materials furnished and installed per this specification section.
   2. Provide electronic PDF files.
   3. Provide product data sheets clearly marked with model type and ratings of the material intended.
   4. Provide copy of contractor's certification of training and partnership with the specified solution.
   5. Provide an example of a typical classroom outlet/jack identification labeling plan.
   6. Provide project manager and field Forman certifications.

C. Test reports:
   1. Provide electronic PDF files of each cable's test report to the owner within 10 days of substantial completion.
   2. Test reports shall be provided on a USB drive.
   3. Provide digital copies of each cable's test report of the O&M manuals.

D. Record Drawings:
   1. A complete set of all telecommunications drawings shall be kept in the job-site office to show the actual installation of cables, equipment, and outlet/jack identification during construction.
   2. Indicate the home run destination for each cable.
   3. These drawings are for the contractor's use to record the as-built installation. These drawings are to be made available to the Architect, Engineer and/or owner for review during construction.
   4. Within 10 days of substantial completion, provide an electronic set of PDF files with all as-built installation changes and outlet/jack identifications drafted in AutoCAD, to the owner's representative for review. Revise the documents per review comments and provide a final version of the record drawings in both PDF and AutoCAD release 2012 or newer to the owner's representative. The architectural x-reference backgrounds shall be bound to each drawing file. These documents shall be incorporated into the overall final set of construction record drawings.
   5. Provide a USB, CD-ROM or DVD with the final record drawings for inclusion into the O&M manuals.

E. O&M Manual Materials:
   1. Provide hard copies of test reports.
   2. Provide the system warranty.
   3. Provide USB, or DVDs with the electronic files of test reports and record drawings.

1.4 REFERENCE CODES AND STANDARDS

A. Installation Standards: Cable and equipment installation shall comply with the following standards. All publications must be of the latest issue and addenda:
   1. NEC®2017: National Electric Code®, 2017
   2. ANSI/TIA-492.AAAC-B – Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class 1a Graded-Index Multimode Optical Fibers
   3. ANSI/TIA-492.AAAD – Detail Specification for 850-nm Laser- Optimized, 50-µm Core Diameter/125-µm Cladding Diameter Class la Graded-Index Multimode Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber
   4. ANSI/TIA-492.CAAB – Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak. Current Edition
   5. ANSI/TIA-568.0-D – Generic Communications Cabling for Customer Premises
   6. ANSI/TIA-568.1-D – Commercial Building Communications Cabling Standard
   7. ANSI/TIA-568-C.2-1 – Balanced Twisted-Pair Telecommunications Cabling and Components Standards
   8. ANSI/TIA-568.3-D – Optical Fiber Cabling and Components Standard
   9. ANSI/TIA-569-D – Telecommunications Pathways and Spaces
   10. ANSI/TIA-606-B.1 – Administration Standard for the Commercial Telecommunications Infrastructure.
   11. ANSI/TIA-607-C – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
   12. ANSI/TIA-862-B – Structured Cabling Infrastructure Standard for Intelligent Building Systems
   13. ANSI/TIA-942-A – Telecommunications Infrastructure Standard for Data Centers
   14. NFPA 70 – National Electrical Code (NEC).
   15. BICSI – TDMM, Building Industries Consulting Services International, Telecommunications Distribution Methods Manual (TDMM)

B. The telecommunications contractor shall have read the above documents and shall be familiar with the requirements that pertain to this installation. The documents may be obtained from:
   1. Global Engineering Documents, 15 Inverness Way East, Englewood, CO, 80112-5776, 800-854-7179, http://global/ihs.com/
   2. BICSI, 8610 Hidden River Parkway, Tampa, FL, 33637, 800-242-7405, www.bicsi.org

C. Materials:
   1. All materials shall UL Listed and labels indicating so shall be affixed where labeling is normally visible.
   2. Equipment shall be regularly catalogued items of the manufacturer and shall be supplied as a complete unit in accordance with the manufacturer's standard specifications with any optional items required for proper installation unless otherwise noted.
   3. All telecommunications connectivity and cabling shall be independently tested to meet current TIA standards.

D. Governance:
   1. The Electrical Code referred to in these specifications is the National Electrical Code as currently adopted by the State of Washington. All work will be provided in strict compliance with the Electrical Code and all regulations that may apply.
   2. Where standards exist, for a particular category, products used on this project will be listed by an OSHA approved Nationally Recognized Testing Laboratory (NRTL) and be approved or listed for the intended service and application.
   3. These specifications do not undertake to repeat the requirements of codes, regulations or NRTL listing or labeling instructions. The Specifications or Drawings may require items or work beyond the requirements of applicable codes or regulations. The stricter, higher quality, greater quantity or higher cost will be allowed, and accommodations must be approved by Pasco School District prior to procurement or installation. It is incumbent on the Installer, material, and equipment suppliers to meet these specifications, applicable codes, regulations, and NRTL listing agency restrictions.

4. The word "Manufacturer" will include the Manufacturer, the Manufacturer's Representative, the Distributor, the Fabricator, and the Supplier of the classification of equipment, system, product, and material.
5. All work, equipment, and systems will be manufactured, provided, repaired, installed, and tested in accordance with the latest edition and all current amendments of the applicable publications and standards of the organizations listed below as of the date of the Contract Documents. When the Specification requirements exceed the requirements of these publications and standards the Specifications will govern:
   a. State Building Code (SBC)
   b. Building Department Inspectional Services
   c. American Society for Testing and Materials (ASTM)
   d. Underwriter's Laboratories, Inc. (UL)
   e. Insulated Cable Engineers Association (ICEA)
   f. National Electrical Manufacturers Association (NEMA)
   g. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
   h. American National Standards Institute, Inc. (ANSI)
   i. National Fire Protection Association (NFPA)
   j. Local Electric Code
   k. Department of Public Safety (DPS)
   l. Building Officials and Code Administrators International, Inc. (BOCA)
   m. Department of Labor USA. Safety and Health Regulations for Construction (OSHA)
   n. Energy Codes
   o. National Electrical Contractors Association (NECA)
   p. National Bureau of Standards (NBS)
   q. Federal Communications Commission (FCC)
   r. Utilities Serving Project.
   s. Fire Department.
   t. Americans with Disabilities Act Applications Guidelines (ADAAG).
   u. Accessibility Guidelines for Buildings and Facilities.
   v. Any and all Federal, State and Local Standards, Codes and Authorities having Jurisdiction.
6. In addition, all phases of the Structured Cabling System installation will adhere to applicable Local Area Network (LAN) Specifications of the IEEE, Electronics Industry Association/Telecommunications Industry Association (TIA/EIA) and Building Industry Consulting Service International (BICSI). The entire system and all components will be Nationally Recognized Testing Laboratory (NRTL) certified to appropriate TIA/EIA performance rating Category, Latest ANSI/TIA/EIA Standards 455-A, 492, 568, 569-A, 570, 606, 607 and 758 (latest revisions), and ANSI/TIA TSB 67, TSB 72, TSB 75, TSB 95 plus other standards as applicable.
7. The Installer will have available at the job site at all times one copy of the latest edition of the Electrical Code, TIA and BICSI Standards applicable to the work as specified within this document.
8. The above requirements will not in any way limit responsibility or requirements to comply with all other codes, standards, and laws.
9. Material, equipment, enclosures, and systems will be designed for use as required to suit the conditions, exterior or interior operation, dust tight, watertight, explosion-proof, or other special types.
10. All materials shall be purchased from Distributors authorized by system Manufacturers to sell new and unused components.

1.5 PREMISE WIRING CONTRACTOR QUALIFICATIONS

A. The contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to data, voice, and imaging network systems. The Contractor shall at a minimum possess the following qualifications:
   1. Possess a valid Washington EL06 Contractors License.

2. Shall be a fully Certified Leviton Premier Network Contractor prior to proposal and must stay current till the completion of the project.
3. All installation technicians must possess current Leviton Installers Certificates, and the contractor shall have a minimum of 6 Current Leviton Certified technicians in the local area with (100 miles) of where the work is being performed.
4. Personnel trained in fiber optic cabling, splicing, termination, and testing techniques. Personnel must have experience using a light meter and OTDR.
5. Personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.
6. Personnel knowledgeable in local, state, province and national codes, and regulations. All work shall comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall be followed.
7. Been in the Low Voltage or Telecommunications Installation business for a minimum of 5 years.
8. All Licensing and certification documents must be available and submitted before the time of bid.

1.6 WARRANTY

A. A Leviton Network Solutions Limited Lifetime Product & Performance Warranty covering all components, equipment and workmanship shall be provided to Pasco School District, submitted in writing with system documentation.
   1. Horizontal link shall be completed with Leviton/Berk-Tek Network Solutions to be eligible for the applicable Leviton Warranty with link performance guarantees.
   2. Approved product shall be listed on the most recent version of the applicable Leviton data sheets for each listed Berk-Tek Leviton Technologies solution.
   3. The Contractor must pre-register as a Premier Contractor with Leviton before the bid and through the installation. Following project completion, contractor is responsible for completing all warranty registration procedures on behalf of Pasco School District.
   4. Should the cabling system fail to perform its expected operation within this warranty period due to inferior or faulty material and/or workmanship, the contractor shall promptly make all required corrections without cost to Pasco School District.

B. Certified Installer shall provide labor, materials, and documentation in accordance with Leviton Network Solutions requirements necessary to ensure that Pasco School District will be furnished with the maximum available Manufacturer's Warranty in force at the time of this project.

C. The installed structured cabling system shall provide a warranty guaranteeing the specified performance in the installed channel performance above the ANSI/TIA-568 requirements for Category 6 or ISO 11801 requirements for Class E_A.
   1. Standards-compliant channel or permanent link performance tests shall be performed in the field with a Leviton-approved certification tester in the appropriate channel or permanent link test configuration.

D. Necessary documentation for warranty registration shall be provided to the manufacturer by the installer.
   1. Certified Premier Contractor must adhere to the terms and conditions of the respective manufacturer's warranty programs.
   2. Shall include a copy of all licensing and certification documents in the deliverable package.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide a complete data cabling and device system as described herein.

B. Work area connectors shall be of a non-proprietary "Keystone"-style port configuration, such that they fit into all furniture, panels, wall plates, raceways, floor monuments, poke-throughs, and AV

boxes without adapters. Maximum density of 6 outlets shall be available in Decora footprint where required.

2.2 ACCEPTABLE MANUFACTURER SOLUTIONS:

A. Subject to compliance with requirements, provide products of the following:
   1. Leviton Manufacturing Co, Inc.
   2. Berk-Tek, a Nexans Company
   3. No Substitutions allowed unless pre-approved in writing by Pasco School Districts IT Operation Manager Glenn R. Whitcomb 90 days prior to bid

2.3 UTP PIN/PAIR TERMINATION ASSIGNMENT

A. The UTP cabling system will have TIA/EIA T568B pin/pair termination assignment. All conductors provided will be properly and consistently terminated at both ends throughout the entire systems. Maintain proper untwist of pairs and removal of jacket per TIA, BICSI, and Manufacturer's recommendations.

B. Category 6 Unshielded Twisted Pair (UTP) Systems
   1. Category 6 UTP 24AWG copper cabling system shall be guaranteed to exceed all TIA-568 link and channel performance requirements and be capable of supporting 1000Base-T (802.3ab) and ISO/IEC 11801 Class E applications for a total distance of 100 meters with equipment cords.
   2. Basis of Design is Berk-Tek Leviton Technologies CX6050 Category 6 UTP System.
   3. Category 6 Performance Parameters, headroom over TIA-568 standard:

Insertion Loss	NEXT	PSNEXT	ACR-F (ELFEXT)	PSACR-F (PSELFEXT)	Return Loss	ACR-N	PSACR-N
3%	3 dB	3 dB	3 dB	5 dB	2 dB	3 dB	5 dB

2.4 HORIZONTAL CABLING SYSTEMS

A. CATEGORY-RATED DATA CONNECTORS (RJ45 JACKS)
   1. Provide modular-type, information connectors/outlets (jacks) for 24-23 AWG copper cable. These connectors shall be individual snap-in style and exceed compliance with TIA-568 specifications. The connectors shall comply with the following:
      a. Shall be 8-position 8-conductor (8P8C) "RJ45"-style modular jack, Category 6, with IDC terminals, T568A/B wiring scheme (use T568B).
      b. Shall be encased in a die-cast housing to protect from potential EMI/RFI and utilize a universal Keystone-style insertion footprint as the manufacturer's main "flagship" line of products.
      c. Category 6 Connectors shall exceed all component performance requirements for Category 6 in the ANSI/TIA-568-C.2 standard, as well as Class E requirements as described in ISO/IEC 11801, from 1 MHz to 250 MHz.
      d. Shielded connectors shall utilize the same form factor, design, and tool-less installation process as the unshielded connectors in the product line.
      e. Shall be tested by an independent testing body such as Intertek (ETL) for component compliance (i.e. "Component rated") to ANSI/TIA-568 and for POE+ applications. Test results shall be published and publicly available without special request.
      f. Shall be in compliance will all National Electrical Codes; compliant with ANSI/TIA-1096-A (formerly FCC Part 68); UL Listed.
      g. When used in the plenum spaces, shall be plenum-rated per UL 2043, and all plastic components shall be made of high-impact, fire-retardant plastic rated UL 94V-0
      h. Shall have a maximum depth of 1.31".
      i. Cable shall be terminated by the use of a snap-on wire manager that holds individual conductors in place during termination and allows for termination without a complete

untwist of each conductor pair. Cables shall terminate onto jack via a “clamshell” closure at rear of connector, affixing termination manager to connector IDC

j. Shall be terminated without the need for any punch down tool or other specialized or proprietary termination tool.
k. Shall be reusable and support a minimum 20 termination and re-termination cycles and be facilitated by simple termination release levers.
l. Shall utilize a method of tine tensioning using polymer springs above the tines (“Retention Force Technology” or similar functionality) that prevents six-position modular plug insertion from damaging either the cord or the module and promotes return of tines to original position.
m. Shall fit the full manufacturer’s range of telecommunications faceplates, outlets, and field-configurable patch panels. No separate product line or style of connectors shall be required for patch panels, faceplate, biscuit, furniture, raceway and/or floor feed applications.
n. Shall be available in 13 TIA 606-B compatible colors and supplied with interchangeable icons (Voice, Data, A/V, and blank, color coded to match the connector face) for easy identification and tracking of data, voice, or other functions. Additional bulk Icons for the connector shall be available separately.
o. Shall be available with an optional internal shutter to protect against dust and debris such as in above-ceiling and in-floor locations.

2.5 PATCH PANELS

A. Telecommunications Room Patch panels shall be manufactured with industry-standard modular non-loaded jack type and shall hold 48 Category 6 terminations at IDF and MDF locations. Panels shall be:
   1. All 48 ports.
   2. Mount in a 2RU space.
   3. Shall be sized to fit an EIA standard, 19-inch relay rack and hole pattern.
   4. Shall come blank so the appropriate colored jacks can be installed.

B. FACEPLATES: Faceplates (wallplates) secure information outlets to the work area. Contractor shall provide and install single gang faceplate kits to house all jacks as required for all work area outlets, workstation base feeds, and furniture openings. Unused telecom backboxes shall receive a solid blank faceplate. Telecommunications faceplates shall:
   1. Utilize a keystone-type (“QuickPort”) footprint to match the approved connectivity manufacturer and be made by the same manufacturer as the connectors.
   2. Plastic and match the color of the power wiring device plates.
   3. Support any connectivity media type, including fiber, AV and copper applications.
   4. Have printable designation labels for circuit identification together with a clear plastic cover.
   5. Be available in single-gang and double-gang configurations.
   6. Have surface-mount boxes and standoff rings available for both single and double gang faceplates.
   7. Have single-port matching color blank inserts available in packs of 10.
   8. Color shall match nearby electrical devices exactly.
   9. Furniture faceplates shall fit knockouts for telecom receptacles and snap in without screw mounts.

C. SURFACE-MOUNT BOX (SMB)
   1. Surface-Mount Box (SMBs) are used to protect terminated Category 6 cables at the endpoints where they are not contained within walls or furniture. Example locations may be Wireless Access Points (WAPs), Group Work Areas fed by conduits run down columns, security cameras, or other network-enabled device locations.
   2. Unless otherwise noted all wireless access point (WAP) shall consist of two category 6 jacks (2) and a single 2-port plastic SMB.
   3. Small Surface-Mount Boxes shall exhibit the following characteristics:

a. Outlet housings for WAPs and other devices shall be a high-density, low-profile design with (2) field-configurable ports, snap-lock cover, and cable knockouts on back.
b. Housing cover shall have raceway knockouts for top and bottom entry.
c. Base shall include Tie-wrap anchor points at all cable entrances.
d. The housing shall be mountable with screws, tape or a single magnet.
e. The cover shall provide the option of securing it to the base with a screw that is hidden under the outlet identification window.
f. Shall be constructed of high-impact self-extinguishing plastic rated UL 94V-0, and be UL Listed and compliant with FCC Part 68 and TIA-568 specifications.

2.6 DATA CABLES

A. Category 6 (100-Ohm, 24 AWG, Category 6 4-pair balanced unshielded twisted pair solid annealed copper conductors

B. Cable shall be characterized to 500 MHz and UL/ETL Listed by the Manufacturer printed on the cable jacket and package, as well as ETL Verified to TIA-568 Category 6 and ISO/IEC 11801 Class E.

C. Cable shall be Plenum-rated (CMP) for any location where plenum cable is required.

D. Outer Diameter: 0.224” max.

E. Cable shall be guaranteed to exceed all TIA-568 link and channel performance requirements and be capable of supporting 1000Base-T (802.3ab) and ISO/IEC 11801 Class E applications for a total distance of 100 meters with equipment cords

F. All category cabling manufacturers must be able to provide documentation from an independent third-party testing agency that verifies through random sampling that cable components perform at or above the levels contained on their product specifications, not simply at or above the standard.

G. Cable may be CMR rated for areas not running through air handling spaces. CMP cable must be used if cable passes at any point through an air plenum or supply/return air handling space.

2.7 BACKBONE CABLING SYSTEMS

A. GENERAL
1. Fiber optic backbone cables shall be 50/125μm Laser-Optimized Multimode Fiber. The cable shall support voice, data, and multimedia applications. The bending radius and pulling strength requirements of all backbone cables shall be observed during handling and installation.

B. OPTICAL FIBER CABLE
1. MULTIMODE FIBER OPTIC CABLE – FIELD TERMINATED
a. Multimode fiber optical fiber cables shall meet all of the requirements delineated within the specifications of ANSI/TIA-568 and ANSI/TIA-492.CAAB (OM3 or OM4). Unless otherwise noted all fiber shall be 6 pair of Laser-Optimized 50 micron optical fiber. Cable jacketing must be appropriate for the environment in which it is installed.
b. Unless otherwise noted all fiber optic cables will utilize Tight-Buffered cable construction and fiber strands with a 900 micron protective sheath.
c. See plans and scope of work for total strand count between locations and noted types of fiber that will supersede these specifications.

C. FIBER OPTIC ENCLOSURES, PANELS AND TRAYS
1. All Fiber enclosures shall provide cross connect, inter connect, and splicing capabilities and contain cable management for supporting and routing the fiber cables/jumpers.
2. Fiber Adapter panel openings shall accept Fiber Adapter Plates (bulkheads), Splice Modules, and plug-n-play MTP modules/cassettes or any combination thereof.
3. 1RU, 2RU, 3RU and 4RU enclosures shall hold up to 3, 6 or 12 adapter plates or cassettes.

4. All Fiber enclosures, panels and trays (units) shall provide cross-connect, inter-connect, and splicing capabilities and contain cable management for supporting and routing the fiber cables/jumpers.
5. Fiber enclosures shall exhibit the following characteristics:
    a. Fiber enclosure shall be available in 1RU, 2RU or 4RU versions to accommodate fiber adapter plates, MTP Modules, and/or termination and splicing of fiber as needed
    b. Enclosure shall inherently accept a 1-panel integrated splice cassette.
    c. Enclosures shall have a sliding tray which can be removed completely from enclosure (from front or rear) to facilitate field terminations and splicing. Sliding tray glides forward and backward providing accessibility to front and rear bulkhead after installation.
    d. 17" depth for high density fiber termination and/or splicing.
    e. Removable transparent hinged doors and slide away covers allow easy access during install and visibility of interior after installation.
    f. Patch cord bend radius guides minimize macro bending.
    g. Stackable and adjustable fiber rings simplify cable routing and organization
    h. Fiber Jumper saddles pivot for improved patch cord routing and organization
    i. Removable rubber grommets protect cable and minimize dust build-up
    j. Multiple mounting bracket positions for 19" or 23" rack and cabinet installation (23" 1RU mounting bracket sold separately)
    k. Constructed of durable polycarbonate plastic and 16-gauge steel, powder-coated black
    l. Door lock option available on front, rear, or both doors
    m. Fiber cable management shall allow for routing, storage, and protection of patch cords, tight-buffer fiber, and backbone cables.
    n. Enclosure shall be available either empty or in custom pre-loaded configurations.

D. FIBER TERMINATION PRODUCTS
1. FIBER CONNECTORS
    a. Aerobic physical connect (PC) fiber optic connectors shall be the primary means of field-terminating individual fiber strands at the enclosure or faceplate location.
    b. Shall meet or exceed the requirements described in TIA-568 and ANSI/TIA-604-10 (LC) Connector Intermateablity Standards
    c. Shall utilize a precision zirconia ceramic ferrule.
    d. Shall be provided in LC, multimode (laser optimized) configurations, terminated on 250 or 900 µm buffered fiber and/or 2mm or 3 mm jacketed fiber.
    e. Maximum connector insertion loss shall be no greater than 0.75 db.
2. FIBER ADAPTER PLATES
    a. The fiber adapter plate shall be modular and functional for use in either a wall-mount or rack-mount enclosure. The adapter plate shall be provided in LC styles, in 12- or 24-fiber configurations. 12-fiber adapter plates are used to terminate 12-fiber cables, and 24-fiber adapter plates are used to terminate 24-fiber (or greater) cables. Do not utilize adapter plates with unused ports at the rear.
    b. The adapter plate shall be compliant to TIA-568 (for performance) and respective TIA-604-X (for intermateability) standards. Adapter plates shall use zirconia ceramic sleeves and be offered in standard fiber type colors pursuant to TIA-568 standards.
    c. LC adapter shall utilities 100% zirconia-ceramic ferrules. Adapter plates shall be offered in with Aqua bulkhead adapters.
3. FIBER JUMPERS AND ARRAY CORDS
    a. Fiber optic LC-LC patch cords, or jumpers, will make LC connections from the rack termination points to the equipment. The jumpers will meet the following requirements:
    b. Factory-manufactured using Single mode OS2 optical fiber. Field terminations on fiber jumpers are not acceptable.
    c. Shall utilize A-B polarity.
    d. Shall exhibit <0.3 dB insertion loss and -25 dB return loss.
    e. Shall be available in standard lengths of 1, 2, 3, 5 and 10 meters and custom-orderable up to any length of feet or meters

f. Provide factory assembled patch cords meeting or exceeding all criteria specified in the horizontal cabling standard

2.8 FRAMES, RACKS AND CABINETS

A. FLOOR-MOUNTED 2-POST RACKS & 4-POST RACKS
1. Universal junction hole pattern matches most manufacturers racks. #12-24 panel mounting holes. UL Listed (File No. E140851) as a communications circuit accessory.
2. Load Rating: 1000 Lbs. (453.6kg) weight capacity when evenly distributed for the height of the rack (84” (2133mm) and shorter).
3. Add (1) front/rear vertical wire manager on each side or between racks. See Wire Management, below.
4. Permanently stamped rack mount unit (RMU) markings included. Double sided universal (5/8" (16mm), 5/8" (16mm), 1/2" (13mm)) mounting spacing.
5. Includes fifty (50) pilot point #12/24 mounting screws.
6. Approved Manufactures
   a. Chatsworth (CPI)
   b. 2-Post Racks (55053-703)
   c. 4-Post Racks (50120-703)
   d. 4-Post Racks for Portables ONLY – Lowell (LER-4432)

B. WALL-MOUNTED CABINET
1. Swing-out steel cabinet body with front and rear access. Black.
2. Pre-punched, 5” deep, locking rear panel with ½”, ¾”, 2 ½” and 3” conduit KOs with interior tie points and attachment points for accessory rack-mounted brackets.
3. Vented cabinet body with one pair of adjustable depth 19” EIA-310-D compliant threaded equipment mounting rails.
4. Vertical cable management.
5. Tinted window front door with rounded edges and lock.
6. Cabinet dimensions 36” Hx24”Wx24”D.
7. Chatsworth #11900-736.

C. VERTICAL WIRE MANAGERS
1. Provide full height, front-and-rear, 6”-8” wide Vertical Wire Managers at the side of and between each 2-post and/or 4-post termination rack or frame. If space will not allow, the 5” wide wire manager may be substituted at row ends only, leaving the 8” vertical wire manager between each rack. Pasco School District approval in writing is required prior to this substitution.
   a. Mounting hardware shall be included to insure the proper installation to infrastructure. It shall mount onto a standard TIA/EIA recognized equipment rack.
   b. The management system shall offer an assortment of accessories, including a bend radius slack loop organizer, cable retainers, and shall accommodate top, bottom, side and pass-through cable routing. Dual hinged, cable concealing covers shall be included.
2. Approved Products:
   a. Chatsworth (CPI)
   b. Vertical Wire Managers 6” (13912-703)

D. HORIZONTAL WIRE MANAGERS
1. Provide 2RU Metal 5 ring horizontal wire managers with doors above and below or between every 2RU of patch panel, as space allows.
   a. Do not coil or wind patch cords inside wire managers.
   b. Use recessed flat wire manager as needed within enclosed cabinets to route patch cords to opposite sides, where the rings of the flat wire managers would interfere with cabinet door closure.
   c. Horizontal Wire Manager (ICCMSCMPK2)

2.9 CABLE SUPPORTS

A. J-HOOKS
   1. All cable shall be supported above ceiling on dedicated cable support hardware.
   2. Cable saddles and J-hooks shall be used to support cables. These must be supported from the wall or on their own ceiling wires, threaded rod, or affixed to building structure by use of beam clamps (on metal beams) or wood screws (on wood beams). Affixing communication cable supports to ceiling support wires is not allowed.

B. CABLE TRAY
   1. In Telecom Rooms, ladder tray (cable runway) shall be installed to support all cable running to racks and cabinets.
   2. Ladder tray to be added to all Telecom Rooms in places where cable is run horizontally.
   3. Ladder tray shall be aluminum, with 12” rung spacing.
   4. Cable shall be combed and bundled in all exposed runs outside walls, in TR/TE, and inside cabinets and wire managers.
   5. All appropriate ladder tray support hardware including angle brackets, rack-to-runway brackets, wall-to-runway brackets, elevation kits, junction splices, butt splices, and grounding jumpers shall be used for a complete and professional installation.

C. JACK/OUTLET BRACKETS
   1. Above-ceiling cable termination locations shall be either wall-mounted or suspended from structure above the drop ceiling. Cables or terminations shall not rest on ceiling grid or equipment above ceiling grid.
   2. For Wireless Access Points and other above-ceiling-mounted communications devices, cables shall land in an above-ceiling bracket which is affixed to dedicated cable support hardware.
   3. Two category-rated jacks may be installed in each above-ceiling bracket. Each above-ceiling bracket will hold a 2-port Surface-Mount Box or 1-U MOS SMB for multimedia applications.
   4. For wall-mounted device locations (above or below ceiling), devices needing to be mounted directly to a backbox will utilize the in-wall mounting bracket to secure the jack inside the backbox.
   5. One category-rated jack can be installed in each in-wall backbox jack mounting bracket. For devices requiring (2) category-rated jacks, (2) in-wall brackets must be used.

2.10 FIRESTOPPING (PERFORMED BY DIV 26)

A. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur. Such devices shall:
   1. Meet the hourly rating of the floor or wall penetrated.
   2. Permit the allowable cable load to range from 0% to 100% visual fill thereby eliminating the need to calculate allowable fill ratios.
   3. Permit multiple devices to be ganged together to increase overall cable capacity.
   4. Allow for future retrofit to install around cables.
   5. Include an optional means to lengthen the device to facilitate installation in thicker barriers without degrading fire or smoke sealing properties or inhibiting ability of device to permit cable moves, add-ons, or changes
   6. Not require any additional action on the part of the installer to open or close the pathway device or activate the internal smoke and fire seal, such as, but not limited to:
      a. Opening or closing of doors.
      b. Twisting an inner liner.
      c. Removal or replacement of any material such as sealant, caulk, putty, pillows, bags, foam plugs, foam blocks, or any other material.
   7. Where single cables (up to 0.27 in. (7 mm) diameter) penetrate gypsum board/stud wall assemblies, a fire-rated cable grommet may be substituted. Acceptable products shall be molded from polymer and conform to the outer diameter of the cable forming a tight seal for fire and smoke. Additionally, acceptable products shall lock into the barrier to secure cable penetration.

B. Where non-mechanical products are utilized, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water, or other forms of moisture characteristic during or after construction.
   1. Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.
   2. Utilize an EMT sleeve as a stub through all walls
   3. Surround annular space between EMT sleeve and wall material with a hardening intumescent caulk.
   4. Utilize re-enterable, non-hardening putty around cables inside a metal sleeve. Do not exceed 40% fill capacity of sleeve and follow all rated assembly requirements per Manufacturer, local codes, and AHJ.
   5. All sleeves to be install by Dev. 26.

C. Cable trays shall terminate at each barrier and resume on the opposite side such that cables pass independently through fire-rated pathway devices. Cable tray shall be rigidly supported independent from fire-rated pathway devices on each side of barrier.

2.11 LABELING:

A. Cables
   1. Horizontal and backbone cables shall be labeled at each end according to Pasco School District labeling standards (see below). The cable or its label shall be marked with its identifier.
   2. Cable labels shall be machine-generated wrap-around labels with multiple cable ID's printed such that it can be viewable in place without turning the cable.
   3. Label cables within 6" of termination point at both ends.

B. Faceplates
   1. A unique location identifier shall be marked on each faceplate to identify its location in the cable plant.
   2. Each port in the faceplate shall be labeled with its own unique identifier.

C. Racks, Panels, Blocks
   1. A unique identifier shall be marked on each piece of connecting hardware to identify it as connecting hardware.
   2. Each port on the connecting hardware shall be labeled with its own identifier to match the other end of the cable.

D. Ceiling Grid
   1. All grid locations that are slated to be used for wireless access point drops above ceiling grid need to be labeled with black on blue TZ type label tape to identify location of drop.

2.12 APPROVED PRODUCT LIST

A. Leviton / Berk-Tek approved base product list
   1. Berk-Tek and Leviton approved material
      a. 4-Pair Category 6 unshielded twisted pair cabling
         1) Plenum
            a) Blue: 10136226
         2) Riser
            a) Blue: 10136339
   2. Head End Termination
      a. QuickPort Patch panel: 49255-H48
         1) Standard User Locations: Black
            a) Black: 61110-RE6
         2) Wireless Access Points:

a) Green: 61110-RV6
3) Audio Visual and Projectors:
a) Blue: 61110-RL6
4) Intercom Clocks:
a) White: 61110-RW6
5) Cameras:
a) Yellow: 61110-RY6
6) HVAC
a) Orange: 61110-RO6
7) Halo Sensors
a) Purple: 61110-RP6

3. User End Terminations
a. White 4-Port QuickPort faceplate with identification windows: 42080-4IS
1) Standard User Locations: Black
a) Black: 61110-RE6
2) Wireless Access Points:
a) Green: 61110-RV6
3) Audio Visual and Projectors:
a) Blue: 61110-RL6
4) Intercom Clocks:
a) White: 61110-RW6
5) Cameras:
a) Purple: 61110-RP6
6) Heat Ventilation and Air Conditioning:
a) Orange: 61110-RO6
4. A complete Laser Optimize 10 Gigabit Optical backbone infrastructure
a. Laser optimized Indoor/Outdoor OM3
1) 6 Strand Indoor/Outdoor Tight Buffered
a) Riser: PDR006EB3010/25-I/O(BLA)
2) 12 Strand Tight Buffered
a) Riser: PDR012EB3010/25-I/O(BLA)
b. Laser optimized Indoor/Outdoor OM4
1) 6 Strand Tight Buffered

a) Riser: PDR006FB3010/25-I/O(BLA)

2.13 UNINTERRUPTABLE POWER SUPPLIES & POWER DISTRIBUTION UNITS

A. MDS UPS 10kVA (UPS shall only be used in MDF unless IDF posses a high density cable count) Contact owner for approval.
1. Output:
a. 10kVA N+1
b. Rack Mount
c. 120/208 single phase
d. Output connections:
1) Four 6-20R
2) (24) 5-15/20R
3) Two L6-30R
e. Input: Hardwire input: 208V, single phase, 88.4A
f. Batteries: 40 minute with additional batteries
g. PDUs: 208V, single phase, 16A
h. PDU connection cords
i. Power cords
j. Remote monitoring web card
k. Tripp Lite Model numbers:
1) SU10000RT3U2TF (Qty. 1)

2) BP240V10RT3U (Qty. 4)
3) PDUMV30HV (Qty. 2)
4) PDUMV20HV (Qty. 1)
5) P036-006 C14-C15(Qty. 14)
6) PDUMV20 (Qty. 1)
7) WEBCARDLX (Qty. 1)

B. UPS
1. Output:
a. 3kVA
b. Rack Mount
c. 120/208 single phase
d. Output connections:
1) Twelve 5-15/20R
2) Two L6-20R
3) Two L6-30R
e. Input
1) 208V
2) NEMA L6-30P
f. Batteries
g. Power cords
h. Remote monitoring web card
i. Tripp Lite model number per IDF:
SMART3000RMXL2U (Qty. 1)
BP192V12-3U (Qty. 2)
WEBCARDLX (Qty. 1)
PDUMV2024 (Qty. 1)
P018-006 C14-C15 (Qty. 8)

C. IDF UPS
1. Output:
a. 5kVA
b. Rack mount
c. 120/208 single phase
d. Output connections:
1) Twelve 5-15/20R
2) Two L6-20R
3) Two L6-30R
e. Input
1) 208V
2) NEMA L6-30P
a) Batteries
b) Power cords
c) Remote monitoring web card
d) Tripp Lite model number per IDF:
SU5000RT4UTF (Qty. 1)
BP192V12-3U (Qty. 2)
WEBCARDLX (Qty. 1)
PDUMV2024 (Qty. 1)

2.14 PRODUCTS PROVIDED BY DIVISION 26

A. The following materials shall be provided under Division 26:
1. Conduit rough-in for boxes in/out of telecommunications rooms and in/out of wall cavities at work stations.
2. Core drilled holes through masonry walls and concrete floors.

3. Conduit sleeves through walls and floors.
4. Pull cords for all conduits where telecommunication cable is to be pulled.
5. Outlet boxes (4-11/16” square) with single gang ring the depth required to be flush with wall trim.
6. 1” EMT conduit stub-ups into accessible ceiling spaces from outlet box.
7. Plastic end cap on stub-out ends.
8. Telecommunication room plywood backboards.
9. Telecommunications grounding bus bars.
10. #2/0 CU. Ground from Telecommunications grounding bus bars to main electrical service ground.
11. Fire Retardant Plywood Backboards:
    a. Provide ¾” x 8’ high fire retardant ACX plywood backboard to cover walls as shown on drawings. Backboard shall bear a seal identifying that plywood is fire rated.
    b. Backboard shall be finished with flat latex, white anti-static sealer or overcoat paint. Paint plywood backboard on all sides and edges prior to mounting on walls. Area around fire retardant seal shall be unpainted so that seal remains exposed and visible.

2.15 EXTRA MATERIALS

A. Furnish and install the extra materials described in subparagraphs below that match products provided. These devices shall be installed as directed during construction. The contractor shall consider a difficult installation that may require ceiling tiles to be removed/replaced, cut-in boxes used and walls to be “fished” to install the devices where directed. Extra materials that are not installed during construction shall be turned over to the owner at the end of construction (closeout). Products that are not installed shall be packaged in their original containers with protective covering for storage and identified with labels describing contents. The contractor shall include the following in their bid:
    1. Field Located Data Drops: The contractor shall include in their bid 30 additional Telecommunication drops complete with 4-port faceplate, (1) Cat 6 jack, (3) snap-in blank fillers, 300 feet Cat 6 cable, installation, termination at each end and testing.
    2. 30 rough-ins including (1) 4” square, deep box with single gang ring and 30’ of ¾” EMT conduit with (2) sweeps.
    3. Contractor shall provide an extra 24 port (spare) CAT 6 patch panel in each cable management telecommunications rack, in each telecommunications room for future terminations.
    4. Labor for installing all extra materials.

B. Submit a fair cost value for these materials and labor with the Division 27 post bid submittals, on the form following this specification section. This fair cost estimate shall include all direct job expenses such as equipment rental, small tool expense, layout and supervision, etc. for a complete installation as if the material were shown on the drawings and taken off for bid. Breakout material and labor costs for each extra material indicated. Unused labor will be Architect or Engineer’s option. This fair cost value may be applied to other work not included in the bid documents.

PART 3 - EXECUTION

3.1 PRE-INSTALLATION CONFERENCE

A. Schedule a conference a minimum of five calendar days prior to beginning work of this section.

B. Agenda: Clarify questions related to work to be performed, scheduling, coordination, etc.

C. Attendance: Communications system installer, General Contractor, Pasco School Districts Representatives and any additional parties affected by work of this section. Pasco School District’s Information Technology must be represented at a preconference meeting prior to scheduling of any work.

D. Copy of Leviton warranty application will be provided by Contractor.

E. Pre-Installation conference may be waived only by Pasco School District.

3.2 INSTALLATION

A. Proper cable handling is critical to maintaining the design integrity of high-performance cabling. Cable handling recommendations include:
   1. Cable must be conditioned above 32 degrees F for 48 hours prior to installation.
   2. Do not use excessive force when pulling cable. The maximum pull-force guideline for a 4-pair horizontal UTP should not exceed 110N (25lbf). Meeting this guideline avoids stretching conductors during installation and the associated transmission degradation.
   3. The minimum bend radius for UTP should not exceed 4 times the cable outside diameter (O.D.)
   4. The minimum bend radius for fiber should not exceed 10x the cable outside diameter.
   5. Traditional bundling of Category 6 cabling for a combed appearance is required in all exposed locations.
   6. In TR, use appropriate horizontal cable management for patch cords on front of patch panels. Also, use appropriate cable management bar(s) for support of terminated horizontal cable.
   7. Do not use vinyl or plastic cable ties due to the potential for over-cinching of cable bundles which can alter the cable geometry and degrade the system cabling performance. Use only hook and loop (“Velcro”) fasteners for bundling of horizontal cables.
   8. Store cable slack in an extended loop configuration to alleviate cable stress. Excessive cable slack in bundled loops or traditional ‘service loops’ to provide additional cable length in TR has been shown to degrade cabling performance and are not recommended.

B. Sleeves shall be provided in walls above ceilings to provide paths wherever cables are being routed.

C. At fire walls provide EMT fitted with nylon throated threaded conduit fittings on each end. Provide fire seal wherever passage through any type of fire wall is required. Unused sleeves are to be provided with metal end caps on both sides.

3.3 SEPARATION OF POWER AND DATA CABLING

A. Design cable pathways to avoid potential sources of EMI. Avoid installing cable near sources of EMI (X-ray equipment, large motors/generators, electrical power cabling and transformers, Radio frequency (RF) sources and transmitters, lighting, copiers, etc.).

B. Physically separate power & data cabling according to relevant code and standard requirements when run in a common pathway.

C. Never run data and Class 1 power cabling in parallel closer than 2”.

D. Avoid crossing cables if possible. If necessary, always cross cables at 90 degrees.

E. Maintain a minimum of 5 in. separation between data cable and all driver-controlled lighting.

F. Minimum separation distances of telecommunications cabling from potential sources of EMI exceeding 5kVA:

G. 24” away from Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways

H. 12” away from Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway

I. 6” away from Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway

J. 47” away from Electrical motors and transformers

3.4 INSTALLATION OF STRUCTURED CABLING SYSTEM

A. PRE-INSTALLATION CONFERENCE
   1. Schedule a conference a minimum of five calendar days prior to beginning work of this section.
   2. Agenda: Clarify questions related to work to be performed, scheduling, coordination, etc.
   3. Attendance: Communications system installer, General Contractor, Pasco School Districts Representatives, and any additional parties affected by work of this section. Pasco School District's Information Technology must be represented at a preconference meeting prior to scheduling of any work.
   4. Copy of Leviton warranty application will be provided by Contractor.
   5. Pre-Installation conference may be waived only by Pasco School District.

B. WARRANTY
   1. A lifetime performance warranty covering all components, equipment and workmanship shall be submitted in writing with system documentation. The warranty period shall begin on the system's first use by Pasco School District.
   2. The project must be pre-registered with Leviton by the installation contractor before installation has begun and shall be concluded by contractor with uploading of test results to Leviton and a full project closeout. Warranty paperwork will be delivered directly from Leviton to Pasco School District.
   3. Should the cabling system fail to perform within its expected operation within this warranty period due to inferior or faulty material and/or workmanship, the Contractor shall promptly make all required corrections without cost to Pasco School District.

C. DRAWINGS AND SPECIFICATIONS
   1. The Contract drawings and specifications form an integral part of the contract documents. Neither the drawings nor the specifications shall be used alone. Drawings are generally diagrammatic and are intended to indicate the scope and general arrangement of work. Work omitted from the drawings but mentioned or reasonably implied in the specifications, or vice versa, shall be considered as properly and sufficiently specified and shall be provided. Misinterpretation of any requirements on drawings, or specifications shall not relieve the Contractor of his or her responsibility of properly completing the Contract.
   2. Pasco School District's Project Manager has the option of changing the location of Electrical and Communication outlets to within 3 meters of designed location prior to rough-in stage at no extra cost to Pasco School District. Pasco School District and Pasco School District's Representative requests a chalk/rough-in walk prior to installation to verify locations.
   3. The Contractor is responsible to take field measurements where equipment and material dimensions are dependent upon building dimensions and to coordinate and provide a chalk/rough-in walk prior to installation to verify locations.
   4. The Contractor shall coordinate with General, Mechanical and Electrical trades as well as Furniture Layout Designer for final workstation outlet locations.
   5. Where conflict exists between drawings and specifications the Contractor shall, make allowance for provision of the component, system, or installation process in a manner which will provide the highest monetary cost components, systems, or installation process. Contractor shall inform Pasco School District's Project Managers of the conflict and obtain approvals prior taking corrective measures.

D. PASCO SCHOOL DISTRICT REQUIREMENTS AND STANDARDS.
   1. Unless otherwise noted a minimum of 1 Category 6 UTP cable and jack shall be installed in all work area outlet (with the exception of wireless access points) locations on a 4-outlet flush mounted faceplate, including offices, utility services, and other common telecommunications locations. The two center positions are to remain blank for future use.
   2. All modular furniture will have a single workstation outlet per cubicle, unless specifically noted otherwise. All partition-wall or demising-walled areas have workstation outlets specifically noted on the Exhibit /Floor Plans.
   3. Two (2) category 6 UTP cables and jacks shall be installed at all Wireless Access Point locations.

4. Wall-phone outlet locations require a single category 6 cable and category 6 jack on a stainless-steel studded wall plate.
5. All termination wiring shall be T568B termination pattern.
6. A minimum of 2 each 4” inch sleeves must be installed in every IDF and MDF for the first one hundred cables. 2 each additional 4” sleeve must be installed if the cabling count exceed 100 cables and 2 additions per hundred from there (example: 120 cables will require 4 each 4” conduits while 220 cables will require 6 each 4” conduits).
7. Sleeves for penetration of walls and floors shall have a one hundred percent (100%) spare capacity and shall be fire-stopped as per code.
8. All sleeves shall be installed by Division 26.

E. PATHWAYS AND TOPOLOGY
1. Utilize “thin film” lubricants only! It has been shown that cable-pilling lubricants will affect your testing as the cable needs several weeks to dry before attenuation levels recover. Use of incorrect cable lubricants will erode cable jacket and void cable warranty.
2. All cable and wire shall be concealed in conduits, floor ducts, paneling, ceiling, or similar areas except at mutually agreed upon areas.
3. Fill capacity in conduit, modular furniture and other horizontal pathways should not exceed 40%. A maximum of 60 % pathway fill is allowed to accommodate unplanned additions after initial installation. To calculate the fill ratio, divide the sum of the cross-sectional area of all cables, by the most restricted cross-sectional area of the pathway.
4. Flat-rung ladder tray shall be utilized within data rooms. J-hooks and other specific cable support hardware shall be used to support cable at all other locations.
5. Pathway design should not exceed (2) 90-degree bends between pull points or pull boxes (PB). If more than (2) 90-degree bends are required, install a pull box between bends.
6. Provide NEC-sized pull boxes for any run greater than 100 feet, or with more than two ninety-degree bends.
7. J-hooks should be randomly spaced 60” or less. Do not exceed J-hook capacity for size and weight limitations.
8. Land wireless access cabling above ceiling, secured onto in-ceiling bracket. A slack loop in the horizontal cabling is not required. Utilize varying-length patch cords when installing wireless access point devices for flexibility in length.
9. Crimp-on modular plugs at wireless access points are not allowed. Terminate all category 6 cabling onto the approved jacks.
10. Mixing of various Category cables in the same pathway is allowed if the applications are appropriate for each category of cable used.
11. Prior to placing any cable pathways or cable, the contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. The arrangements to remove any obstructions with the Project Manager need to be determined at that time.
12. Maintain a distance of at least 12 inches from all power conduits and cables, and 6 inches from all fluorescent lighting fixtures. Do not install power feeders 100 amps or greater above or within 5 feet of telecommunications backboard. Do not install telecommunications conduits above power panels or switchboards.
13. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
14. The backbone subsystem shall include cable installed in a vertical manner between floor telecommunications room/closets (TCs or IDFs) and the main or intermediate cross-connect in a multi-story building and cable installed horizontally between telecommunications room/closets and the main or intermediate cross-connect in a long single-story building.
15. Unless otherwise recommended by Pasco School District, all fiber cables will be encased in interlocking armor. All fibers will be terminated in the Telecom Rooms or Cabinets in rack-mounted enclosures equipped with sufficient ports to allow for growth, slack storage space and splice trays if required to terminate and secure all fibers.

16. Adequate riser sleeve/slot space shall be available with the ability to ingress the area at a later date in all Telecommunications rooms/closets, such that no drilling of additional sleeves/slots is necessary. Sleeves may need to be provided and installed under the scope of this Project.
17. The backbone cables shall be installed in a star topology, emanating from the main cross-connect to each telecommunications room/closet. An intermediate cross-connect may be present between the main cross-connect and the horizontal cross-connect.
18. For voice or data applications, 4 pair UTP or fiber optic cables shall be run using a star topology from the telecommunications room/closet serving that floor to every individual information outlet.
19. Backbone and Horizontal pathways shall be installed or selected such that the minimum bend radius is maintained both during and after installation.
20. All horizontal pathways shall be designed, installed, Sand grounded to meet applicable local and national building and electrical codes.
21. Install ¾" x 4' x 8' fire-rated plywood across all walls in telecom rooms, from 6" AFF to 8'-6" AFF. Coat with 2 coats of white paint. Do not paint over fire rating stamp.
22. Contractor (shall firestop all used pathways which enter or leave the telecom rooms via conduit or slot. Contractor is responsible for installing sleeves at each wall or partition penetration, and firestopping all fire-rated penetrations. Intumescent caulk shall be applied around the outside of each sleeve, and intumescent putty inside the sleeve or conduits around the cables. Appropriate fill ratios must be followed when penetrating fire-rated walls.
23. Do not run fiber cables in conduits which are less than 2" in diameter.
24. Abandoned cable shall be removed from pathways (i.e., from tunnels, manholes and conduit) under scope of this project. Previously unknown or unidentified cable which is apparently abandoned prior to work shall be brought to the attention of Pasco School District for authorization prior to removal.

F. GROUNDING:
1. Refer to section 27 05 26 for specifications on Grounding and Bonding.
2. All grounding (earthing) and bonding shall be done to applicable codes, standards and regulations.
3. Shielded cabling channels shall include appropriate method of bonding shield to approved ground for proper EMI/RFI mitigation.
4. Shield Continuity Testing shall be enabled when shielded cabling channels are installed.
5. All shielded and armored cables shall be bonded to a telecom grounding system via shielded patch panels at the rack locations. Shielded Category-rated connectors must be properly installed to maintain electrical ground conductivity along entire length of cable and at both ends of the cable. UTP connectors shall not be used on shielded cables at either end.
6. Shielded Patch cords shall be provided for use and employed at each workstation location utilizing shielded cable. Shielded patch cords can be identified by their gray color and metallic RJ45 plug. Shielded patch cords are not required at the patch panels.
7. Telecom Contractor shall bond and ground all telecom room metals. Telecom Contractor shall provide and install TIA-rated Telecommunications Grounding Busbar (TGB) at all MDF and IDF locations, and an in-cabinet grounding busbar at each remote wall-mounted cabinet or telecom enclosure. All ground lugs shall be 2-hole make-up.
8. Division 26 will provide all bus bars and the connection between the TGB and building ground.
9. Telecom installer will ground, and bond all armored and/or shielded cables, racks, cabinets, ladder tray, racking, and shielded panels to telecom grounding busbar within the telecom rooms.

G. CABLES AND TERMINATIONS:
1. Check plans for final determination of faceplate colors or consult with the Electrical Engineer to Pasco School District prior to install.
2. Install additional cables at drop locations and in quantities indicated on the drawings. Do not exceed manufacturers' recommendations for maximum allowable pulling tension, side wall pressure or minimum bending radius. Use pulling compound as recommended by cabling manufacturer.

3. All horizontal cables, regardless of media type, shall not exceed 90 m (295 ft) from the telecommunications outlets in the work area to the horizontal cross connect.
4. The combined length of jumpers, or patch cords and equipment cables in the telecommunications room/closet and the work area shall not exceed 10m (33 ft).
5. The Contractor shall observe the bending radius and pulling strength requirements of the 4 pair UTP and fiber optic cable during handling and installation.
6. No run of UTP cable between horizontal portions of the cross-connect in the telecommunication closet and the information outlet shall contain splices.
7. In a false ceiling environment, a minimum of 3 inches (75 mm) shall be observed between the cable supports and the false ceiling. Minimum 6" is preferred.
8. J-hooks shall be provided for all suspended cable, at a semi-irregular spacing not to exceed 5 feet between supports. Cables shall be supported by dedicated low-voltage cable support hardware. Support of cables or hanging hardware by means of supports or surfaces related to other trades or applications is not allowed.
9. Provide a full-size service loop (at least once around the inside edge of the box) in each J-box in the communications system.
10. Install all cable in ceiling spaces with J-hooks of at least 1" in width to disperse the weight on the bottom cables. Homerun all cable to nearest TR Cabinet.
11. Comply with ANSI/TIA-569 for conduit and splice box sizing.
12. Install modular jacks at all outlets shown; one data jack for each data cable at each faceplate or termination point. Install additional cables and modular jacks as indicated on the drawings. Do not "split pairs" between different jacks.
13. Terminate cables at each jack location and at termination board or patch panel. Follow industry guidelines and manufacturers' recommendations and procedures as required. All termination hardware shall be rated to exceed their associated Category rating as specified above.
14. For enclosed ceiling WAP locations, install and terminate two category 6 (2) cables to approximate location as shown on plans. For open-ceiling environments, secure cables and surface-mount boxes to nearest appropriate support structure.
15. For in-ceiling WAP locations, secure jacks inside a surface-mount block mounted to in-ceiling metal assembly, and provide a 5' patch cord or longer, as needed, to connect device to its final determined location in ceiling.
16. Label and identify each outlet and cable for data circuits. Label at outlet end and at termination board or patch panel with matching designations.
17. Provide data outlets in surface raceway at 26" on center unless otherwise indicated.
18. Extreme care must be taken not to nick any of the copper conductors when removing jacket. Use rip cord to expose pairs for termination onto Insulation Displacement Contacts. You can also use a precision stripper that allows the technician to set the depth of the blade.
19. Maintain twists as close as possible to the point of termination. Untwisting of copper pairs should not exceed ¼" to the termination point.
20. Manage the cable bundles in a symmetrical orientation. For example, in a 48-port patch panel, distribute 24 cables through the vertical cable management on the left rear side of the rack and 24 cables through the vertical cable management on the right rear side of the rack.
21. Do not dress cables in bundles larger than 24 cables. Multiple 24-cable bundles may be run in parallel with evenly-spaced Velcro cable ties in an orderly sequence.
22. For cable management on rear of patch panel, cable shall sweep into termination points and be supported by appropriate rear cable management.
23. Horizontal patch cord management is required on all installations.
24. Maintain cable bend radius 4X outer diameter (UTP only) when mounting faceplate onto EMT backbox, box-eliminators or furniture knock-outs.
25. Faceplates and SMBs shall be fully installed and labeled prior to testing.

H. ABOVE-CEILING AND WALL-MOUNTED WIRELESS ACCESS POINTS AND DEVICES:
1. All WAP locations shall receive (2) Category 6 cables from the nearest TE or TR (IDF). Multimedia, security and other video devices shall receive (1) Category 6 cables as shown on drawings, documents and details.

2. WAP and other communications cables shall terminate on patch panels in the TE/TR (IDF). WAP cables shall terminate on Category 6 information outlets and shall be terminated above *the* ceiling in a 2-port SMB.
3. SMB, jacks, and patch cords used in ceiling spaces shall be riser-rated.

I. FURNITURE CABLING:
1. The contractor will pull all voice and data cables in advance of the installation of the modular furniture workstations, and coil at base-feed or above ceiling for power pole feeds. Upon furniture arrival, the contractor will feed the cables through power poles or base feed/wall connected data/telecom conduit and terminate as specified on the floor plans.
2. Contractor to coordinate with Pasco School District's furniture vendor for timing of the installation of systems furniture, and installation of electrical and voice/data cabling. Overtime may be required for this and other phases of the project work, and bids, plans and schedules must reflect actual work demands. Contractor shall consider all costs in their bids for installation.

J. TERMINAL BLOCKS AND PATCH PANELS:
1. Arrange all terminal blocks in a manner that allows natural wiring progression and minimizes crossing of wires.
2. Dress and comb all incoming cable bundles in groups of 24 cables each. Eliminate crossed cables and "divers".
3. Ground all shielded patch panels to telecom ground source via paint-piercing washers to a grounded rack, or via direct ground wire to telecom bus bar.

K. IDF ROOMS:
1. The Data and Telco Rooms are a transition point between the backbone and horizontal distribution pathways. The rooms shall be able to contain data or telecommunications' equipment, cable terminations and associated cross-connection wiring. Closet spaces are not to be shared with electrical installations, other than those directly for telecommunications, video, security, and information systems equipment. The rooms are not to be shared with other unrelated building service, for example plumbing. Any conflicts with these specifications require the approval of Pasco School District's project manager.
2. Contractor shall submit a drawing of the IDF room showing layout of all components including necessary and required electrical outlets, conduits, environmental requirements, and wire termination fields prior to start of the job. Any jack densities noted in these specifications are estimates only. The drawing will designate the most effective, scalable, jack termination cabling design to facilitate data/telecom outlets shown on the lease exhibits. Pasco School District's Project Managers must approve drawings prior to installation.
3. All racks, panels, and equipment finished shall be anchored to meet local seismic zone requirements and industry standards. The equipment racks are to be anchored to the concrete floors via "Unistrut or equal metal framing strut systems", threaded rod, concrete anchors, bolts and washers.
4. The overhead cable ladder system will provide a route for the Category 6, and other communication cables while providing stability to the equipment racks.
5. The vendor is responsible to provide and install the specified count of 19" EIA rack-mount 7' (45U) 2- post racks, Black, as required in the new IDF. The vendor is responsible for submitting IDF layout drawings to Pasco School District for approval prior to installation.
6. The contractor shall provide high capacity horizontal and vertical cable manager channels are required in all data and equipment racks, and the racks will contain sufficient vertical and horizontal cable managers to facilitate the patch panel density and placement installed by the contractor.
7. Contractor will install raceways, boxes, managers, and enclosures as indicated according to manufacturer's written instructions. Securely fasten each component to the surface to which it is mounted and remove burs and sharp edges from all ladder tray.
8. A 12" ladder rack system is required and will be provided by the contractor and installed in the IDF to provide cable support to the rack system. This includes all the required ladder rack support items such as rack to runway kits, wall angle brackets, ceiling supports, splices

(junction and butt), radius drops and j-bolts. The final ladder rack layout will be included in the IDF layout drawing described above.

9. Provide and install as needed in the IDF room 4’ x 8” x 3/4” fire-rated plywood board and labeled with fire rating stamp facing into the room to accommodate rack ladder support, cabling support, grounding platform, data and voice equipment. Paint backboard white (leave stamp visible). Location of installation is to be determined with approval by Pasco School District.

L. PATCH CORDS:
   1. Owner Furnished Owner Installed (OFOI).
      a. Install Category 6 patch cords at the equipment cabinet between Category 6 patch panel and Pasco School District switches. Dress and bundle patch cords as appropriate for final installation.
      b. Install fiber optic patch cords at the equipment cabinet between fiber patch panel and Pasco School District switches. Dress and bundle patch cords as appropriate for final installation
   2. Contractor Furnished Contracted Installed
      a. If the wireless access points are part of the proposal, then the contractor will be required to install Category 6 patch cords between the work area outlet and the wireless access points. Neatly route, dress and bundle patch cords to assure they are esthetically please for Pasco School District if patching is done by the contractor.

M. LABELING:
   1. Provide machine-generated labels appropriate for all components supplied and installed. Under no circumstances shall handwritten labels be used.
   2. Each faceplate, cable, or data outlet (drop) will be numbered with a unique identifier clearly indicating the voice and data jacks by Closet ID, Rack ID, Panel ID, and Port ID.
      a. Ex: 128.1.A-24 (IDF 128 / Rack 1 / Panel A / Port 24)
      b. Label at the panel to match
         1) The labeling scheme shall not include duplicates of any cable identification across the entire cable plant.
         2) Labeling procedure will meet TIA-568, TIA-606 (Class 2 Administration) and BICSI Standards.
         3) The labeling scheme will be provided at all locations within the cable infrastructure:

N. All inspections which expose conditions not meeting Pasco School District standards as described above must be reported to Pasco School District prior to installation. Pasco School District may require additional work to bring site conditions up to Standard. Areas to explore shall include, but not be limited, to the following items.

O. Insufficient or failed HVAC flow in the IDF with the appropriate exhaust system. Air temperatures shall not exceed 78 degrees sustained.

P. It is recommended to recess any fire sprinklers in the IDF to prevent accidental damage and associated risks.

Q. Lighting layout fixture pattern is to provide sufficient lighting over front and back of each equipment rack.

R. In the IDF room, a minimum of (2) 20-amp, dedicated, duplex power outlets box must be provided to support network electronics. Outlet boxes must be installed on the top of the equipment rack in a location approved by Pasco School District and the Network Support (IT) representative.

S. Any penetration of fire and smoke barrier must be approved by the Lessor and/or Pasco School District. Such penetrations must be properly treated according to industry standards, all applicable codes and with the current addition of the National Electrical Code. Minimally, metallic sleeves patched-in with fire seal putty, and filled with pliable intumescent materials meeting the applicable codes shall be used. In all cases, the Contractor shall be responsible for compliance with all federal, state, and local regulations in effect.
   1. During installation, any penetration of fire wall shall be sealed with approved firestop material.

3.5 TESTING

A. COPPER TESTING:
   1. Test all equipment and each outlet, horizontal cable, termination block, patch cords, etc. to verify compliance with requirements. Testing shall consist of attenuation and NEXT across all splices and devices installed in the field and shall meet latest requirements of EIA/TIA. Re-terminate any cable or connection found to be defective.
   2. Tester is to be a Level IV device or better, and configured with the specific cable installed, and the Permanent Link test will be performed according to the Category's standard methodology. All parameters must exhibit a PASS test result prior to project completion. PASS*, FAIL* or FAIL test results will not be accepted.

B. FIBER OPTIC TESTING:
   1. Cable length shall be verified using sheath markings. The guidelines and procedures established for Tier 1 testing in TIA/TSB-140 shall apply.
   2. All fiber optic cables shall be tested from the site's MDF to each fiber terminals located in the IDF.
   3. The Contractor shall conduct a bi-directional power meter (loss) test of each fiber optic station and riser cable at both wavelengths, 850/1300nm for MM and 1310/1550nm for SM.
   4. No individual station or riser fiber link segment (including connectors) shall measure more than 2.0 dB loss for LC, and 1.5dB loss for MTP. LC links shall be tested with LC jumpers from the LC cassette to the tester. MTP links shall be tested either with an MTP tester and array cord, or with an MTP-LC breakout harness and LC duplex fiber tester.
   5. Tests shall be conducted using ANSI/TIA-526-14A, Method B. Test results evaluation for the panel to panel (backbone) shall be based on the values set forth in ANSI/TIA-568.
   6. The Contractor shall provide an electronic printout for each strand tested with the Power Meter and the OTDR.
   7. Where concatenated links are installed to complete a circuit between devices, the Contractor shall test each link from end to end to ensure the performance of the system. After the link performance test, has been successfully completed, each link shall be concatenated and tested. The test method shall be the same used for the test described above. The evaluation criteria shall be established between Pasco School District and the Contractor prior to the start of the test.
   8. All installed cables must meet or exceed the defined standards for performance. The Contractor shall take all steps and all expense necessary to clean, repair or replace any optic link not meeting the standard.

C. TEST RESULTS:
   1. Repair and resolve any shortcomings in the test results. Mitigation efforts may require re-termination or replacement of the jack, outlet or cable. Repairs or attempts to resolve test failures will be completed solely at the expense of the Contractor.
   2. Provide test results to Manufacturer and Pasco School District representative in native Tester format. Upon request, provide a copy of the tester software and license, if needed, at no charge to Pasco School District representative.
   3. Include PDF of full test results, summary index in electronic format on CD or memory stick in the O&M package upon project completion.
   4. Cabling systems shall meet or exceed the electrical and transmission characteristics of the systems specified.
   5. Cable segments and links shall be tested from both ends of the cable for each of the construction phases. (Verify that cable labeling matches at both ends).
   6. The system shall not be considered certified until the tester has acknowledged that the performance of the physical layer of the system has been fully tested and is operational at the completion of the installation phase.
   7. After the installation is complete, in addition to any other required testing as described herein, and at such times as Pasco School District/Engineer directs, the Contractor shall be present while Pasco School District conducts an operating test for approval. The installation shall be demonstrated to be in accordance with the requirements of this specification. Any defects

revealed shall be corrected promptly at the Contractor's expense and the tests performed again.

8. The test results information for each link shall be recorded in the memory of the field tester upon completion of the test. The tester shall be capable of storing test data in either internal or external memory. The external media used shall be left to the discretion of the user.
9. Test results saved by the tester shall be transferred into a Windows based database utility that allows for maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered as well as any printed reports generated from the software application.
10. Test results shall be provided in both native Tester format as well as comma separated variable (.csv), Portable Document File (.pdf), plain text (.txt), or hypertext markup language (.html/.htm). A copy of the tester native test software must be provided to Pasco School District or Pasco School District's representative for comparison of results.
11. Test Results for CATEGORY 6 shall include the following:
    a. Applicable room number of jack location (room number per Contract Documents)
    b. Applicable Telecommunications Room number
    c. Circuit I.D. number with corresponding jack identifier
    d. Wire Map – shall include the following:
        1) Continuity to the remote end
        2) Shorts between any two or more conductors
        3) Crossed pairs
        4) Reversed pairs
        5) Split pairs
        6) Any other mis-wiring
    e. Length
    f. Insertion Loss
    g. Near-end Crosstalk (NEXT) Loss
    h. PS-NEXT (Power Sum Near End Cross Talk)
    i. FEXT (Far End Crosstalk)
    j. ELFEXT (Equal Level Far End Cross Talk)
    k. PS-ELFEXT (Power Sum Equal Level Far End Cross Talk)
    l. Propagation Delay
    m. Delay Skew
    n. Return loss
    o. PSFEXT (Power Sum Far End Crosstalk)
    p. PSACRF (Power Sum Attenuation to Crosstalk Ratio, Far End)

12. Completion of all wiring, projects, moves adds or changes will be considered complete when contract contacts PSD representative that work has been completed.

3.6 PROJECT CLOSEOUT

A. Operating and maintenance manuals shall be submitted prior to testing of the system. A total of (4) manuals shall be delivered to Pasco School District. Manuals shall include all service, installation, and programming information.

B. Provide a full set of "as-built" (redline) drawings in PDF format. Drawings to depict final location and drop/cable identification numbers and labels which match the test reports. Include (1) hard copy paper format of all as-built drawings in 30"x42" size or equivalent, posted in each telecom room involved in the project.

3.7 TRAINING

A. Offer four (4) hours training on the operation and installation of the data system, at job site, at no cost to Pasco School District.

END OF SECTION 27 15 00

SECTION 27 4100 - SOUND REINFORCEMENT SYSTEMS GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This section is a Division 26 Basic Electrical Materials and Methods section and is part of each Division 26 section.

B. Drawings and General Provisions of contract, including General and Supplementary conditions, Division 01 Specification sections and all Division 26 sections apply to work of this section.

C. Specification sections; 27 4172 Dining/Commons Sound System; 27 4173 Main & Aux Gymnasium Sound Systems; 27 4174 Music Classroom Sound Systems; 27 4175 Collaborative Sound System; 275104 Weights, Cardio, Aerobics & Wrestling Sound Systems 27 51 17 Audio Visual Systems

1.2 PROVISIONS

A. The General provisions in this specification apply to all the sound systems provided in this contract.

B. Work under this contract includes all labor, materials, tools, transportation services, supervision, coordination, etc., necessary to complete the installation of the sound systems, as described in these specifications and illustrated on the associated drawings. The systems include the following major items:
   1. Wireless Microphones
   2. Assisted Listening Devices and Antennas
   3. Complete sound reinforcement systems including speakers, amplifiers, processors, mixers and other related equipment.
   4. Cables and control wiring.
   5. Speaker rigging hardware
   6. Equipment racks
   7. Control Equipment
   8. Device rough-in, conduit and mounting hardware
   9. Commons AV System integration.

C. The contract also includes:
   1. Verification of dimensions and conditions at the job site.
   2. Preparation of submittal information.
   3. Installation in accordance with the contract documents, manufacturer’s recommendations, and all applicable code requirements.
   4. Initial tests and adjustments, written report, and documentation.
   5. Instruction of operating personnel; preparation of user manuals.
   6. Maintenance services; warranty.

1.3 RESPONSIBILITY AND RELATED WORK

A. Coordinate work with the Owner, General and Electrical Contractors, and the scheduled work of other trades.

B. The Sound system contractor is responsible for the supply of all wiring and specialty back boxes to the electrical contractor for installation.

C. Conduit; wireways; floor, wall, pull, and junction boxes; and AC Power circuits and ground wiring to the Sound System are provided by the Electrical Contractor. This does not, however, relieve the Sound System Installer from responsibility for a complete working system, and coordination with the Electrical Contractor is required to achieve a proper conduit system. The sound system contractor shall coordinate and define the division of work with the electrical contractor.

D. AC Power shall be distributed within the Sound System Racks by the Sound System installer.

E. Supply accessories and minor equipment items needed for a complete system, even if not specifically mentioned herein or on the drawings, without claim for additional payment.

F. The contractor shall provide all materials, even though not specifically mentioned herein, which are necessary for the proper integration of the system to provide the functions listed in compliance with all specified requirements.

G. Notwithstanding any detailed information in the Contract Documents, it is the responsibility of the Sound System Installer to supply systems in full working order. Notify the Architect of any discrepancies in part numbers or quantities before bid. Failing to provide such notification, supply items and quantities according to the intent of the specification and Drawings, without claim for additional payment.

H. Obtain all permits necessary for the execution of any work pertaining to the installation, or any operation by the owner.

I. Execute all work in accordance with the National Electric code, the National Electrical Safety Code, and all applicable local and State codes, ordinances, and regulations. If a conflict develops between the contract documents and the appropriate codes and is reported to the architect prior to bid opening, the Architect will prepare the necessary clarification. Where a conflict is reported after contract award, propose a resolution of the conflict and, upon approval, perform work.

1.4 REFERENCES:

A. National Fire Protection Association (N.F.P.A.).

B. National Electrical Code (N.E.C.).

C. American National Safety Institute (A.N.S.I.).

D. Electronics Industries Association (E.I.A.).

E. Sound System Engineering (2nd Edition), Davis and Davis, Howard W. Sams, 1987.

F. Audio System – Design and Installation, Giddings, Howard W. Sams, 1990.

1.5 SYSTEMS DESCRIPTION

A. The project includes sound reinforcement systems for the Commons, Main Gymnasium, Auxiliary Gymnasium, Weight Room, Cardio Room, Aerobics Room, Wrestling Room, Music Rooms, and Dining/Commons Spaces.

B. Sound reinforcement systems shall be stand-alone for each space with a distributed ceiling speaker system for audio playback.

1.6 SUBMITTALS

A. Submit all shop drawings and submittals in accordance with project documents. Quantities listed herein are the minimum required of this contractor.

B. Shop drawings and submittal data shall contain sufficient information to describe the work to be performed. Drawings shall be executed at an appropriate scale, not smaller than 1/8” = 1’0”. Submit 1 reproducible shop drawing set. Submit all Shop Drawing information at one time. Information shall include but not necessarily be limited to:
   1. Wiring diagrams. Complete, detailed wiring diagrams for all systems, based on the contract documents and detailed wiring of connections, both at equipment and between equipment racks and wiring in conduit.
   2. Floor plans showing all devices with terminal-to-terminal wiring
   3. Legend providing detailed description and catalog number of each type of device
   4. Identify backbox requirements for rough-in
   5. Loudspeaker locations, orientation, rigging and aiming details
   6. Rack elevations
   7. Patch panel layouts and designation (labeling strips).
   8. Drawings describing fabrication of consoles, enclosures, supports, tables, etc.

9. Location of all equipment in racks, consoles, or on tables, with dimensions, wire routing and cabling within housings; AC power outlet and terminal strip locations.
10. Custom Plates. Provide complete shop drawings on custom fabricated plates or panels. Drawings to include dimensioned locations of components, component types, engraving information and plate material and color.
11. Schematic drawings of any custom circuitry or equipment modifications, including connector pinouts and component lists.
12. A material list of all equipment to be furnished arranged in specification order. This list shall be followed by catalog data sheets, arranged in specification order, of all equipment to be furnished. Where a data sheet shows more than one product, indicate the model being proposed with an arrow or other appropriate symbol.

C. Contract close-out submittals:
1. Keep a complete set of drawings on the job, note any changes made during installation, and submit 1 corrected set of reproducible drawings showing Work as installed.
2. Submit the following data for review, prepared as indicated, at least one week prior to acceptance testing (exceptions noted):
3. System Reference Manual: Furnish 3 copies binders, sized to hold the material. Provide tabular dividers with permanent legends for the following sections:
4. A list of all equipment, indicating manufacturer, model, serial number, and equipment rack location. Update following acceptance testing, if changed.
5. As-built wiring diagrams and system block diagrams. A list of settings of all semi-fixed controls. Update following acceptance testing.
6. Photographically reproduced schematic wiring diagrams of each major sub-system, based on the as-built documentation, at a reduced scale easy to handle but fully legible. Maintenance Instructions, including Installer’s maintenance phone number(s) and hours; maintenance schedule; description of products recommended or provided for maintenance purposes, and instructions for the proper use of these products.
7. Any other pertinent data generated during the project or required for future service.

1.7 QUESTIONS

A. Submit questions about the Drawings and Specifications to the Engineer in writing prior to issuance of the final addendum. Replies will be issued to all bidders of record as addenda to the Drawings and Specifications and will become part of the Contract Documents. The Engineer and Owner will not be responsible for oral clarification. Questions received less than 72 hours before the bid opening cannot be answered.

1.8 SUBSTITUTIONS

A. Requests shall be submitted to the engineer no later than fourteen days before the bid opening.

B. Proposals must be accompanied by complete technical data including: Equipment list on contractor’s letterhead listing major system components, such as loudspeakers, amplifying and control equipment, cabling etc. Compilation of manufacturers catalogs or specification sheets of major components and block diagrams. It is the sole responsibility of the contractor to prove equality to the satisfaction of the engineer including, laboratory test data, fabrication techniques, installation and testing procedures. Potential bidders submitting proposals for prior approval must provide, upon request, a working demonstration system for the Owner's inspection prior to final acceptance to ensure that the submitted components are equal to the specified in all functional aspects.

C. Other qualified manufacturers will be considered subject to approval by owner and engineer after review of complete technical data.

D. Confirmation of the acceptance of substitutions shall be issued to all bidders of record as addenda to the Drawings and Specifications and will become part of the Contract Documents. The Engineer and Owner will not be responsible for oral clarification.

E. Substitutions after Bid award will only be considered when a Product becomes unavailable through no fault of the Contractor. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

F. Vendors not complying with the prior approval requirements and conditions set forth will not be considered.

1.9 QUALITY ASSURANCE

A. General:
   1. Contractors wishing to bid on the Sound System installation of the project must submit qualification documentation to the owner and engineer at least two weeks prior to date of bid opening.
   2. Qualification of contractors will take place prior to the submission of bids. Bids from contractors not receiving prior qualification approval from the owner and owner's engineer will not be accepted.
   3. Notification of approval of contractor's qualifications and experience will be given one week prior to opening of bids.

B. Qualifications of Experience: The following criteria will be used as a standard for judging installation qualification and project experience:
   1. Installing Contractor to have previously installed jobs of similar magnitude completed within the last five years. Similar magnitude includes; equal or larger venue size, system cost and complexity. Provide evidence of at least one such completed job for inspection by the owner and engineer. Information to include project scope, system description, system cost, and owner and engineer references.
   2. Installing Contractor to have at least five years' experience with equipment and systems of the types specified.
   3. The Installing Contractor shall maintain a fully staffed and equipped service facility located within 150 miles of the project site and shall be a franchised dealer and authorized service facility for the major brands specified.
   4. To qualify as a bidder, the installation shall be made by a licensed and bonded contractor holding a valid Electrical Contractor's License and Administrator's Certificate as prescribed by the State of Washington. All work covered by this specification is to be performed by a holder of a current State of Washington Specialty Electrician for limited energy systems.
   5. The Installing Contractor shall have staffing and computer systems to produce acceptable quality shop drawings and project record documents. Schematic diagrams, speaker location, orientation, rigging, fabrication and layout details to be produced using AutoCAD 2019 or later.
   6. The contractor shall employ individuals who have received advanced training in the safe suspension of speaker rigging or the contractor shall include as part of the sound system bid, the costs for a licensed rigger for the purpose of providing a safe and properly suspended speaker system. The contractor shall employ individuals with advanced training in the proper orientation of Central Speaker Arrays and High Level Distributed Speaker Systems.
   7. The Contractor shall regularly use TEF analysis in the analysis and documentation of Sound Reinforcement Systems and shall employ individuals with advanced training on the proper use of TEF.
   8. Installing contractor to be an authorized distributor of the products specified. Second sources of products is not allowed.

C. Contractor qualification submittals must include all of the following:
   1. A description of the installing contractor's fulfillment of qualifications and experience in all areas listed in the section above.
   2. A brief company description outlining company history including how long the company has been in business, the number of personnel employed, etc.
   3. Resumes of staff that will be involved in working on the project and their roles. Include education, training, experience, professional societies and notable contributions to the industry.

4. Representative project list. Include a project description, company personnel who worked on the project with their involvement, and a reference point of contact. Note whether the key personnel involved in these projects are still employed with the company.
5. Samples of project documentation. Include schematic diagrams, speaker orientation and rigging details, panel fabrication details, and any other applicable documentation.
6. Approved Sound System Contractor:
    a. Evco Sound, (509) 535-8718
    b. Dimensional Communications; (509) 481-9009
    c. System Solutions Northwest (509) 783-8272
    d. Avidex (509) 455-6873
    e. Other contractors shall submit for prior approval and will be listed by addenda.

1.10 PROJECT CONDITIONS

A. Verify all conditions on the jobsite applicable to this work. Notify the Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. The drawings diagrammatically show cables, conduit, wiring, and arrangements of equipment fitting the space available without interference. If conditions exist at the job site which make it impossible to install work as shown, recommend solutions and / or submit drawings to the Architect for approval, showing how the work may be installed.

1.11 ACCEPTANCE TESTING

A. Provide personnel familiar with all aspects of the system to assist during acceptance testing in accordance with part 3 of this specification.

B. The process of acceptance testing the system may necessitate moving and adjusting certain component parts; perform such adjustments without claim for additional payment.

1.12 WARRANTY

A. Installer shall warrant equipment to be free of defects in materials and workmanship for not less than one year after date of Substantial Completion. Defects occurring in labor or materials within one-year warranty shall be rectified by replacement of repair. Within the warranty period, provide service calls and requests for information within a 24-hour period, and repair or replace any faulty item within a 72-hour period without charge, including parts and labor.

B. This warranty shall not void specific warranties issued by manufacturers for greater periods of time. Nor shall it void any rights guaranteed to the owner by law.

C. Contractor to provide Owner with exact beginning and ending dates of the warranty period. Include the name of the person to call for service and telephone number. This information to be part of Project Record Drawings.

1.13 EQUIPMENT SUPPLIER

A. Procure all sound system equipment through authorized factory distributors.

B. All equipment must be installed by factory-authorized distributors located within 150 miles of project site.

C. All components and materials supplied to be new, of the manufacturer’s latest model, and accompanied by full manufacturer’s warranty.

D. Single Source Responsibility: Provide material produced by a single manufacturer for each type of material or equipment item.

E. The sound reinforcement system contractor shall furnish and install all materials, even though not specifically mentioned herein, which are necessary for the proper implementation of the system so that the system shall perform the functions listed herein in compliance with all the specified

requirements. Only race way and wire pulling can be sub bid out of this section. System supplier is responsible for system wire and installing all devices.

1.14 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firm (material producer) with more than three years of production experience, whose published literature, clearly indicates general compliance of products with requirements of this section.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. All major components shall be of the same manufacturer and furnished and installed by a factory authorized and factory trained installer / distributor. The installer / distributor shall no less than five years relationship directly with the factory as the named installer / distributor. Upon request the installer / distributor shall provide documentation written on the manufacture's letterhead attesting to this fact.

B. All equipment and materials shall be new, and shall conform to applicable UL, CSA, and ANSI provisions. Take care during installation to prevent scratches, dents, chips, etc.

C. Regardless of the length or completeness of the descriptive paragraph herein, each device shall meet all of its published manufacturer's specifications. Verify performance as required. Where two or more acceptable products are listed, the Installer may use either at his option.

D. Provide shaft locks or security covers on all non-user operated equipment having front panel controls. Install this equipment at the conclusion of Acceptance Testing as described in Part 3.

E. Custom rack panels shall be 1/8-inch-thick aluminum, standard EIA sizes, brushed black anodized finish unless otherwise noted. (Brush in direction of aluminum grain only.) Custom connector plates (speaker, microphone, etc.) are typically stainless steel; however, it is this Installer's responsibility to verify plate finish with the Architect. Plastic plates will not be accepted.

F. All engraving shall be 1/8-inch block sans serif characters unless noted otherwise. On dark panels or pushbuttons, letters shall be white; on stainless steel brushed natural aluminum plates, or light-colored pushbuttons, letters shall be black.

G. For each sound system, an equipment rack shall contain all system electronic components.

H. For each sound system, a storage drawer shall be provided with the permanent equipment rack for storage of system microphones and cables.

I. For each sound system, high quality microphones and companion accessory equipment shall be provided as noted elsewhere in the sound system specifications. Provide for microphone pick-up of "live" program material from locations as shown on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate work with other trades to avoid causing delays in construction schedule.

B. Mount equipment and enclosures plumb and square. Permanently installed equipment to be firmly and safely held in place. Design equipment supports to support loads imposed with a safety factor of at least three. Seismic bracing shall be installed on appropriate equipment where local codes require such installation.

C. Cover edges of cable pass-through holes in chassis, racks, boxes, etc., with rubber grommets or Brady GRNY nylon grommetting.

D. Provide 120V AC for powered speakers. Coordinate all rough-in for powered speakers to conceal outlet and cord from view.

E. Provide two dedicated AC power circuits and Grounding at each fixed location rack. Coordinate final connection of power and ground wiring to each fixed location rack. Hardwire power wiring directly to internal AC receptacles to ensure uninterrupted operation. Label each outlet as to which AC circuit is feeding it and provide the same information in the circuit breaker panel.

F. Install a 1 inch by ¼ inch copper ground buss bar top to bottom in each rack, insulated from the rack. Ground equipment chassis not having a three-wire power cord to these busses using 6/32 nuts, bolts and lock washers with No. 12 wire. Connect green ground wire from each AC outlet in rack to this buss bar. Connect each rack buss bar to main ground wire in local power panel with properly sized insulated cable.

G. Equipment Racks:
   1. Mount equipment in racks and consoles and fully wire and test before delivery to job site. Racks located on concrete floors in equipment rooms or non-finished spaces to mount on a 4 inch wood or concrete riser.
      a. Provide ventilation adequate to keep temperature within the rack below 100 degrees F.
      b. Looking at the rack from the rear, locate AC power wiring on the left; line level audio, video, and RF wiring on the right. Panels or equipment mounted on the rear rack rails shall not block access to any front mounted components.

H. System loudspeakers shall be permanently mounted and wiring shall be installed according to the National Electrical Code.

I. System Wiring:
   1. Take precautions to prevent and guard against electromagnetic and electrostatic hum. For line level audio signals, float cable shields at the output of source device. Shields not connected to be folded back over cable jacket and covered with heat-shrink tubing. Do not cut off unused shields.
   2. Cabling between components shall be concealed within the rack, and connections for external equipment brought out to receptacles located on rack panels on the front side of the rack. Connections shall be identified with labels permanently laser engraved into the rack panel
   3. AC power connection to the rack shall be by means of a dedicated AC circuit mounted inside the equipment rack.
   4. Exercise care in wiring; damaged cables or equipment will not be accepted. Isolated cables of different signals or different levels; and separate, organize, and route to restrict channel crosstalk or feedback oscillation in any amplifier section. Keep wiring separated into groups for microphone level circuits, line level circuits, loudspeaker circuits, and power circuits.
   5. Make joints and connections with rosin-core solder or with mechanical connectors approved by the Architect; where spade lugs are used, crimp properly with ratchet type tool. Spade lugs mounted on 22 gauge or smaller cable to be soldered after crimping.
   6. Execute wiring in strict adherence to:
      a. Phillip Giddings. Audio System Design and Installation. Indianapolis: Howard W. Sams & Co., 1990.
      b. Don Davis and Carolyn Davis. Appendix II, Recommended Wiring Practices. In Sound System Engineering, 2nd Edition. Indianapolis: Howard W. Sams & Co., 1989.
      c. In accordance with standard professional practice.
      d. Wiring entering equipment racks should connect via terminal blocks. Terminal blocks shall be fully exposed, labeled, and mounted in rack. If quantity of terminals is too numerous to fit in rack, terminal blocks may be located on the wall mounted plywood terminal board adjacent to rack. Mounting boards to be ¾ inch A/C grade of hardwood plywood painted flat black. Terminal board wiring to meet the same requirements as internal rack wiring described below.
   7. Route unbroken microphone, audio line, and control wiring from receptacle plate / chassis to patch panel / rack. Remove spliced cables and replace without additional charge to the Owner.
   8. Connect cable to activate components through screw terminal connections and spade lugs whenever available. Make connections to speaker transformers with properly sized closed end connectors crimped with factory approved ratchet type tool. Wire nut or “Scotchlock”

connectors are not acceptable. Do not wrap audio cable splices or connections with adhesive backed tape.

9. Run vertical wiring inside rack in properly sized plastic raceway with snap-on covers (Panduit Type E series). Horizontal wiring in rack to be neatly tied in manageable bundles with cable lengths cut to minimize excess cable slack but still allow for service and testing. Provide horizontal support bars if cable bundles sag. Neatly bundle excess AC power cables from rack mounted equipment with plastic cable ties. Rack wiring to be bundled with plastic cable ties or lacing twine. Electrical tape and adhesive backed cable tie anchors are not acceptable.
10. Connect loudspeakers positive polarity; a positive pressure at the microphone will cause a positive pressure at the speaker diaphragm. Use the same wire color code for speaker wiring throughout the project.
11. Provide adequate service loops so that equipment mounted on rack slides may be pulled fully out, to their locked position without straining cable.
12. Wiring and connections shall be completely visible and labeled in rack. Termination resistors shall be 1 per cent tolerance; fully visible and not concealed within equipment or connectors.
13. Isolate cables carrying signals at different levels and separate to restrict channel bleed-through and feedback oscillation in any amplifier section.
14. Keep wiring separated into five groups of conduit provided for microphone level circuits (level below –20dBm), line level circuits (up to +30dBm), loudspeaker circuits (above +30 dBm), video and power circuits.
15. Isolate all wiring from conduit ground.

J. Install all rack mounted equipment with black 10-32 button head machine screws with Allen drive or stainless steel 10-32, oval head machine screws, Phillips drive.

K. Mount trim potentiometers, custom circuit cards, relays, and transformers (except large 70V units) in shielded enclosures, and mark their function and connections with engraved Lamacoid labels.

L. In accordance with IEC-268 standard, all XLR connectors shall be wired pin 2 high, pin 3 low, and pin 1 shield.

M. All patch panels shall be wired so that signal “sources” (outputs from devices) appears on the upper row of a row pair; all “loads” (inputs to devices) appear on the lower row of a row pair. All patch panel designation strips shall utilize alphanumeric and descriptive labels. The jack positions in each horizontal row shall be numbered sequentially from left to right. The horizontal jack rows shall be lettered sequentially from top to bottom. The alphanumeric identification of each jack shall be included on the functional block drawings.

N. Equipment and Cable Labeling
   1. Provide engraved Lamacoid labels on the front and rear of active equipment mounted in racks. Mount labels in a neat, plumb and permanent manner. Embossed labels are not acceptable. Equipment labels to have at least three lines of engraving with the first line listing the general name of the device.
   2. Provide an engraved label over each user-operated control that describes the function or purpose of the control. Label size to be adjusted to fit available space.
   3. Engraved labels to have 1/8-inch-high characters minimum. Labels to be black with white characters except where indicated.
   4. Cables and wiring to be logically, legibly and permanently labeled for easy identification. Labels on cables to be adhesive strip type covered with clear heat-shrink tubing. Factory stamped heat shrink tubing may be used in lieu of the adhesive strip style label. Hand-written or self-laminating type labels are not acceptable.
   5. Wiring designations to be an alphanumeric code that is unique for each cable. Locate the cable designation at the start and end of each cable run and within 2 inches of the point of termination or connection. For cable runs that have intermediate splice points, the cable shall have the same designation throughout with an additional suffix to indicate each segment of the run. Actual cable designation assignments to be determined by Contractor. Add cable designation codes to system schematic drawings included with Project Record Drawings.

6. Label each terminal strip with a unique identification code in addition to a numerical label (Cinch MS series) for each terminal. Show terminal strip codes on system schematic drawings included with Project Record Drawings.
7. Provide adhesive labels on the rear of equipment where cables attach to indicate the designation of the cable connected at that point.

3.2 CONTRACTOR TESTS AND ADJUSTMENTS

A. Verify the following before beginning actual tests and adjustments on each system:
   1. Electronic devices are properly grounded.
   2. Powered devices have AC power from the proper circuit and hot, neutral, and ground conductors are connected correctly.
   3. Insulation and shrink tubing are present where required.
   4. Dust, debris, solder splatter, etc. is removed.
   5. Cable is dressed, routed, and labeled; connections are consistent with regard to polarity.

B. After all equipment specified herein for each system has been completely fabricated, wired and is in operating condition in the Sound Contractor's shop, performance tests shall be conducted by the Sound Contractor on the system to determine if the installation and components comply with these specifications. The Sound Contractor shall supply competent personnel and shall use laboratory quality test instruments. A complete report for the system showing all parameters of each procedure, printer/ plotter graphs or self-developing photographs of the measured results, calculations, interpretations, etc. shall be prepared. The document shall be signed by the technician responsible for the project. All tests shall be run from each system input to each system output.

C. Electrical testing:
   1. The following test shall be performed for each system and adjustments made to meet each listed performance criterion:
      a. Overall frequency response of the complete electronic system (unequalized) shall be 20 to 20,000 Hz +2 dB. Equalizing circuits shall be temporarily set in the indicated "flat" position.
      b. Total harmonic distortion from microphone input to power amplifier output at rated power shall be less than 1% for the frequency range of 20 to 20,000 Hz.
      c. The overall broadband hum and noise from 20 Hz to 20 kHz using 6 dB/octave filter at 12.47 kHz shall be at least 65 dB below the rated output from system input to output.
      d. Each speaker line shall have its total speaker load measured and recorded, including its line matching transformer. Line impedance shall be measured at 100, 400, 1000, 4000, and 10,000 Hz. Total load impedance connected to an amplifier shall, under no circumstances, be less than the rated output load impedance of the power amplifier.
      e. The total system shall be installed from microphone to loudspeaker in Absolute Polarity. A positive pressure on the microphone shall produce a positive pressure from the loudspeaker.

D. Acoustical testing:
   1. After all electronic equipment specified herein is fully installed at the jobsite and the speakers are fully installed, the system shall be equalized and acoustically tested by the Sound Contractor utilizing the Time Delay Spectrometry (TDS) testing technique. Personnel, test equipment, complete report, and signing shall be as described under Testing and Equalization.
   2. The loudspeakers shall be oriented and sound levels set to provide an even distribution of the Direct Sound Field frequency response of 250 to 10,000 Hz throughout the seating area.
   3. The system shall deliver a minimum of 95 dB average program level with additional 10 dB peaking margin to any seat in the audience at distortion level below 1% THD over the specified frequency range.

E. Testing Documentation:
   1. Documentation of test shall be provided to the Engineer and shall consist of the following:
   2. The test results as listed under Electronic System Testing.
   3. The test results as listed under Acoustical Testing.

4. The un-equalized house curves of the frequency response made with the measuring microphone.
5. The equalized house curve made with the measuring microphone.
6. The level settings for each electronic component.
7. List of personnel and test equipment used.
8. Qualifications of personnel (formal training and experience).

F. Preparation for Acceptance, prior to final inspection:
1. Temporary facilities and utilities shall be properly disconnected, removed and disposed of off-site.
2. All systems, equipment and devices shall be in full and proper adjustment and operation, and properly labeled and identified.
3. All materials shall be neat, clean and unmarred and parts securely attached.
4. All broken work, including glass, raised flooring and supports, ceiling tiles and supports, walls, doors, etc. shall be replaced or properly repaired, and debris cleaned up and discarded.
5. All extra materials, portable equipment, and spares shall be delivered and stored at the premises as directed.
6. Audio System Tests. Perform the following tests and adjustments, supplying test equipment required. Follow EIA Standards RS-160 and RS-219 in performing tests. Make corrections necessary to bring system(s) into compliance with the specifications.
7. Measure and record the impedance of each loudspeaker / speaker line circuit terminating at the equipment rack. Use 100 Hz for low frequency speakers, 1k Hz for mid-range speakers, 4 kHz for high frequency horns. For full range devices, use 1k Hz.
8. Check polarity of loudspeakers with an electronic polarity checker and by applying music program or constant power per octave (pink noise) signal to system while walking through the transition areas of coverage from one loudspeaker to the next. Transition should be smooth with no apparent shift in source from one speaker to the next.
9. Apply sine wave sweep signal to each loudspeaker system, sweeping from 50 Hz to 5k Hz and at a level 10dB below full amplifier output, and listen for rattles or noise. Correct if apparent.

3.3 CLOSEOUT

A. Portable component delivery: Deliver to the owner all non-fixed components. Provide a transmittal listing all components and obtain sign-off from the owner's designated representative. Provide copies to owner, project manager & architect.

B. Training: Provide one technician on site for four hours for instruction to Owner designated personnel on the use and operation of the system, scheduled by an instructor fully knowledgeable and qualified in system operation. The System Reference Manuals should be complete and on site at the time of this instruction. Digitally record the training session. Provide Owner with three copies.

C. Record drawings: At the completion of training and all final adjustments, the contractor shall update the system shop drawings to indicate locations, conduit routing and any modifications made to provide an accurate representation of the final accepted installation.

END OF SECTION 27 41 00

SECTION 27 4172 - COMMONS SOUND SYSTEM

PART 1 - GENERAL

1.1 GENERAL

A. Refer to Division 26, for general electrical and installation requirements that apply to this section. Comply with all requirements of Division 26.

B. Refer to specification section 27 4100 Sound Systems General Provisions for requirements that apply to this section.

1.2 PERFORMANCE REQUIREMENTS

A. Provide even distribution of the sound throughout the seating areas and the main paying floor, allowing no more than +/- 3 dB variation from front to back and side to side for the one octave band centered at 4kHz. Total variation shall be no more than +/- 3 dB from best to worst seat.

B. Provide equalization to provide reasonably uniform frequency response throughout. Equalization to be flat typically +/- 2 dB from 100Hz to 2kHz. Provide a 3 dB per octave attenuation above 2kHz and a 12-dB attention above 15kHz and below 50Hz.

C. Provide speaker system capable of delivering 95dBa SPL.

D. The articulation loss of consonants (% Alcons) shall be less than 10%.

1.3 SCOPE OF WORK

A. Provide a Sound Reinforcement and Music Playback system for the Commons/Exterior Courtyard areas. The system shall operate in both an automatic and manual mode.

B. System Operation
   1. The system shall provide for the mixing, equalization, amplification and switching to allow for either simultaneous or single operation of the Dining/Commons or Exterior Courtyard. Switching shall be via simple pushbutton switch action. Switch position shall indicate the current system mode. The default configuration upon power up is in the separate room configuration. Combining requires depression of the pushbutton switch at the Dining/Commons Remote Volume Control panel.
   2. Selection of the power up or down sequence button shall activate the sequential switcher. Lighted Main Power switch to be located in Equipment Rack. LED’s on Remote Volume Control plates shall indicate the current system power status.
   3. Microphone and auxiliary outlets shall be provided and terminate on the DSP/mixer/preamplifiers.
   4. The digital signal processor shall be capable to execute up to four (expandable) presets minimum.
   5. Speaker system shall be a high quality, high sound pressure level system, utilizing as low impedance design with coverage for the Commons and exterior. Speakers shall be arranged as shown on the contract drawings and system block diagrams to allow for symmetrical level and equalization control by the DSP.
   6. Wireless microphones shall be fitted with an antenna distribution amplifier to allow for a single pair of antennas to be used. Provide antenna guards in the Commons.
   7. The speaker system shall be zoned to provide for control of audio distribution.
   8. The DSP units shall be rack mountable and programmed via external software. The processors shall provide individual inputs and outputs, system equalization and individual speaker sector selection through use of pre-sets. DSP units shall provide inputs for School Intercom that will have priority and mute local program material and an interface with the Fire Alarm system for highest priority to mute Intercom and local program material when activated.

9. A permanent wall or floor mounted equipment rack shall contain all system electronic components. System loudspeakers ceiling mounted and wiring shall be provided according to the National Electrical Code.
10. A storage drawer shall be provided with the equipment rack for storage of system microphones and cables.

C. These specifications are based on products manufactured by BiAmp / JBL / Crown / Shure as provided by an approved vendor.

PART 2 - PRODUCTS

2.1 EQUIPMENT RACK – PERMANENT

A. The equipment rack shall be constructed of 16-gauge cold -rolled steel throughout. It shall have 1/2" to 3" conduit knockouts on the bottom, and rear flanges. It shall have internal louvers for ventilation and 3RU storage drawer.

B. Rear door shall be mounted on a continuous hinge. The front door shall be hinged, have a cylinder lock the same in style but keyed differently from the rear door, and have a low-profile handle. The door shall be supplied to clear all control knobs. Fill all blank spaces.

C. Lowell LER-3527 w/ LMB27 Caster Base, Solid front and and rear rack rails - Permanent Rack.

D. Odyssey CXP1112W Portable Mixer.

2.2 A.C. POWER CONDITIONER / SEQUENCER

A. Furman CN-2400S for permanent rack.

B. Furman PL-8C for portable mixer rack.

2.3 RACK MOUNTED DIGITAL SIGNAL PROCESSOR

A. The Rack Mounted Digital Signal processor shall be capable of providing up to ten input and six outputs. The configuration of the processor shall provide eight microphone or line inputs and additionally eight-line outputs. The Processor shall be configurable and controlled via a standard PC laptop. Additional control can be accomplished through manufactures remote control panel, third-party RS-232 control panel or via an Ethernet connection. The manufactures programming software shall include on-screen display of total audio design, multi-level security coding and built-in diagnostic tools. The programming software shall also provide the ability to select, view and calibrate any virtual hardware device programmed into the system. The Digital Signal Processor shall be UL listed. Provide with Logic Box for Fire Alarm override interface

B. The DSP shall provide 8 Microphone/Line inputs, 8 Flex input/ outputs and 8 outputs. It is equipped with signal processing and control functions necessary for sound reinforcement, permitting all parameters to be set at mixer.
1. QSC Core 110F DSP

2.4 PORTABLE PERFORMANCE MIXER

A. The Portable Performance Mixer shall be compact with scalable remote I/O. It shall be easy to use with quick access to analogue style interface. There shall be 20 faders, 4 layers, 48 Input Channels into 30 assignable busses into 20 Mix Outputs. There shall be a 8.4” color touchscreen, 10 user assignable SoftKeys and employ dSnake technology. A 48 channel 2-way option port shall be provided on the rear and shall be compatible with the range of interface modules available from Allen & Heath

B. Allen and Health SQ5 mixer with (2) AB-168 Stage Boxes, SQ-5-RK19, AB-168-RK19

2.5 EIGHT ZONE POWER AMPLIFIER

A. The power amplifier shall be capable of producing an audio output of 500 watts RMS per channel at less than 0.1% distortion into an 8-ohm line and shall have the ability to bridge or quad bridge the outputs. The frequency response shall be within +0.5 / -0.5 dB from 20 to 20,000 Hz, and the noise level shall be at least 102 dB below rated output.

B. The amplifier shall contain eight independent amplifier channels. Each channel shall have its own independent input and may be configurable for a 2, 4, 8 ohm and 70volt or 100volt output.

C. The amplifier shall include an automatic and self-restoring protective circuit that protects against damage from prolonged overloads and from extreme overloads, such as a shorted output line, and is not subject to activation by program peaks or other instantaneous overloads. The protective circuit shall be a thermostatically controlled type which automatically removes power from the amplifier when damage is threatened and automatically restores the amplifier to operation when the danger is past.

D. The amplifier shall have input level controls, a bridging input transformer. Input connections shall be plug-in for ease of installation and service.

E. Model: Crown DCi 8/600 amplifier. Each speaker shall receive its own amplifier channel. Enough amplifier channels to match speakers as shown floor plan.

2.6 CEILING MOUNTED 15” FULL RANGE DISTRIBUTED LOUDSPEAKERS

A. JBL AC2215 Surface Mount 2-way Speaker with factory u-bracket. Quantities and locations as shown on the drawings.

2.7 HIGH LEVEL POINT SOURCE SPEAKERS

A. The loudspeaker system shall incorporate two transducers; the low-frequency driver shall be 12-inch cone transducer and the high-frequency driver shall be a 1.75-inch diaphragm compression driver. The sub-woofer system shall incorporate one 18-inch low-frequency transducer. The loudspeaker system shall have a frequency response within -6 dB at 53 Hz to 18 kHz, useable frequency range within -10dB at 50 Hz to 20kHz, nominal coverage within -6dB shall be 75 degrees axisymmetric with maximum SPL at one meter shall be 131 dB peak. The sub-woofer shall have a frequency response within -6dB at 48 Hz to 134 Hz usable frequency range within -10 dB at 44 Hz to 148 Hz, maximum SPL at one meter shall be 130 dB.

B. The speakers shall incorporate circuitry enabling crossovers and time alignment. The system shall have digital signal processing (DSP) functions providing; Digital Extension and Excursion Processing (DEEP), a non-distorting low-frequency EQ circuit increasing low-frequency extension without distortion or over-excursion and intrinsic correction which evens the dispersion of energy throughout the physical listening area.

C. The speaker systems shall have:

1. Line in via a male 3-pin XLR jack
2. Remote gain connection via a 3-pin “Euro” jack
3. Line out via a male 3-pin XLR jack, balancing full-range line-level output of line in signal input
4. AC in via a blue locking powerCON keyed connector input
5. AC out via a grey locking powerCON keyed connector output

D. The loudspeaker enclosure shall be constructed of impact-resistant ABS plastic, painted white with the front of the enclosure protected with a white powder coated 18-gauge steel grille. The top of the enclosure shall be equipped with integrated SOLO Rigging System fittings to enable the enclosure to lock to the bottom of either another loudspeaker or sub-woofer, or to an array frame for flown deployment. The bottom of the enclosure shall be equipped with integrated SOLO Rigging System fittings to enable the locking with another loudspeaker or sub-woofer.

E. The sub-woofer enclosure shall be constructed of birch plywood, painted white with the front of the enclosure protected with a white powder coated 16-gauge steel grille. The top of the enclosure shall be equipped with four integrated suspension points with M10 eyebolts. The bottom of the enclosure shall have slip-resistant feet that nest into alignment receptacles (feet cups) on top of another loudspeaker enclosure.

F. Manufacturer shall be QSC Audio:
   1. Array frame, model KLA AF12
   2. Sub-woofer, model KLA18 (1) per array
   3. Loudspeaker, model KLA12, (3) per array
   4. Outdoor speaker, model JBL Control 30 or equal

G. Provide (1) Adaptive Technologies SAS-500-WM wallmount system per line array location.

H. Provide with control from Extron Touch Panel Control system.

2.8 MICROPHONES

A. The microphone shall be a directional type with wide-range frequency response, uniform from 50 to 16,000 Hz. The diaphragm shall be non-metallic and shall have a high-density foam blast filter to prevent dust and magnetic particles from reaching the diaphragm. The neodymium element and acoustic cavity shall be shock isolated from the outer case.

B. Nominal impedance shall be 250 ohms. The line shall be balanced to ground and phased. The output level shall be -52 dB. EIA sensitivity rating shall be -155 dB. The case shall be made of die-cast aluminum. The finish shall be dark blue.

C. A 25' two-conductor shielded, broadcast-type rubber-jacketed cable with Switchcraft A3F connector installed shall be provided. The microphone shall have a built-in cable connector to mate with the Switchcraft A3F. A stand clamp and vinyl protective pouch shall be supplied.

D. Model: Shure SM58S. Provide six. Provide six 25-foot extension cables, Whirlwind MK425.

2.9 COURT ANNOUNCER MICROPHONE

A. The microphone shall be a directional type with wide-range frequency response, uniform from 50 to 16,000 Hz. The diaphragm shall be non-metallic and shall have a high-density foam blast filter to prevent dust and magnetic particles from reaching the diaphragm. The neodymium element and acoustic cavity shall be shock isolated from the outer case.

B. Nominal impedance shall be 250 ohms. The line shall be balanced to ground and phased. The output level shall be -52 dB. EIA sensitivity rating shall be -155 dB. The case shall be made of die-cast aluminum.

C. A 25' two-conductor shielded, broadcast-type rubber-jacketed cable with Neutrik XX series connector installed shall be provided. The microphone shall have a built-in cable connector to mate with the Neutrik XX Series.

D. Model: Astatic 878HL-2.

2.10 WIRELESS MICROPHONE SYSTEM

A. The wireless microphone system shall consist of a rack-mounted diversity receiver unit and companion hand-held or headworn microphone/transmitter. Receiving antennas shall be mounted adjacent to the loudspeaker cluster, with coaxial cable extended to the rack-mounted receiver. The wireless microphone system shall operate in the "UHF high band" on a fixed frequency between 174 to 216 MHz. (system 1) and 470-937.5 MHz (system 2) as appropriate for the region.

B. The receiver shall be of the 24 bit digital audio type, incorporating advanced receiving circuitry and AES 256-bit encryption.

C. The receiver shall feature LED indicators to show the action of received signal, carrier presence, and a display for peak audio level. Chassis and cover of the receiver shall be constructed of aluminum for 100% shielding.

D. Audio frequency response shall be 20Hz to 20 kHz +1 dB depending on the microphone type. Signal to noise ratio shall be 94 dB typical.

E. The receiver shall provide a Gain Adjustment Range from -18 to +42dB in 1dB steps.

F. The receiver shall be mounted in the equipment rack with remote antennae located as shown on the drawings.

G. The transmitter shall have an RF power output from 1 to 10 milliwatts. Shure proprietary digital modulation type shall be employed. Radiated harmonic and spurious emissions shall be lower than acceptable FCC limits. Battery type shall be or equal to AA alkaline or rechargeable type. Battery life shall be no less than eight hours typical.

H. The transmitter shall be FCC-type accepted under parts 90 and 74.

I. Model: Shure QLXD. Provide one QXLD1/ 85 system with SM35 Headworn Microphone and one QLXD24/58 Handheld transmitter system on the frequency supplied.

J. Provide (1) Shure UA844+SWB Antenna Distribution Amplifier.

2.11 MICROPHONE FLOOR STAND

A. The microphone floor stand shall be equipped with wear-proof grip-action positive lock clutch. Tube assembly shall be chrome finished and consist of 1-1/8" diameter seamless brass and 7/8" cold rolled steel. Stand height shall be adjustable from 34" to 62". The base shall include a variable integral piston-type air suspension system to counter-balance microphone weight, allow rapid height adjustment, and to preclude any sudden downward motion of the tube assembly.

B. Stand termination for microphone shall be industry standard 5/8 to 27 thread adapter. The cast-metal one-piece round base shall be 17" in diameter, finished in black and equipped with chrome center cover.

C. Model: Ultimate Support MC-07B. Provide six.

2.12 ASSISTIVE LISTENING SYSTEM TRANSMITTER AND RECEIVER

A. Transmitter:
   1. The assistive listening system transmitter shall operate in the 72 to 76 MHz auditory assistance band as approved by the FCC. The transmitted field strength shall not exceed 80 mV per meter at 3 meters. The operating frequency shall be digitally selectable by rear panel thumbwheel switches to any of 37 frequencies in the approved band. The transmitter shall be FCC and DOC approved.
   2. Maximum FM deviation shall not exceed a total of 30 kHz. Frequency stability shall be controlled by a phase-locked loop frequency synthesizer with crystal reference and shall be accurate to within +/-0.005% from 0 to 50 degrees centigrade. The transmitter shall have a 50 ohm BNC antenna connector for a local or remote antenna. The RF output level shall be adjustable by a rear panel slid switch providing 1/4, 1/2, and full power.
   3. The transmitter shall have XLR balanced and RCA unbalanced input jacks selectable to balanced microphone, balanced and unbalanced line, and unbalanced speaker audio signals. There shall be a front panel control to adjust the audio input level with an LED audio level display. There shall be a switchable high-pass filter providing a 6 dB per octave roll-off at 180 Hz. There shall be an audio processing chain consisting of wide-band AGC, multi-band compression, Aphex Aural Exciter, and peak limiting. There shall be a front panel control to regulate the overall amount of audio processing and a switchable 1 kHz test tone to aid setup and receiver tuning.
   4. The transmitter shall be powered by an external AC line to a 12 VDC power adapter. The front panel shall have a power switch with LED and an LED to indicate proper RFD carrier operation. There shall be a 1/4" stereo monitor jack with volume control. The transmitter shall be rack mountable in a standard one rack unit by 1/2 rack steel package.
   5. Model: Williams Sound MM 457PRO system configured under current ADA requirements. Provide 20 ~~receivers~~ transmitters with 5 being hearing aid compatible.

B. Receiver:
   1. The assistive listening system receiver shall operate in the 72 to 76 MHz auditory assistance band as approved by the FCC. It shall be continuously tunable by a concealed control over that band. It shall have an infrared acceptance of 50 kHz with AFC function for long-term frequency stability. Audio frequency response shall be 100 to 10,000 Hz.
   2. The receiver shall be housed in a high-strength plastic case with an integral pocket clip. The on/off/volume control shall be properly marked and the only control that is exposed. There shall be a standard 1/8" mono headphone jack for audio output. The jack shall be recessed to provide stress protection for the headphone plug. The receiver shall provide an audio output of 140 mW into a 32 ohm load. The receiver shall operate on two standard AA batteries, and contain built-in recharging contacts for operation with rechargeable batteries and a suitable drop-in recharger.
   3. Model: Williams Sound PPA-R37N. Provide quantities as required by current ADA codes for a facility of this type and occupancy. Provide 20 receivers with 5 being hearing aid compatible

2.13 AUXILIARY COMPONENTS

A. The microphone outlets, as located on the drawings, shall have dual three-pin XLR-type and one each two-gang dual XLRF mixer input mounted on a single-gang stainless steel plate.

B. Auxiliary jacks, as located on the drawings, shall provide line level and audio input positions for the sound system. Auxiliary jacks shall be provided with both 3.5mm jack and RCA phono jack for line input shall be mounted together with two microphone outlets on a double-gang stainless steel plate. Where indicated on the drawings provide MCM Custom Audio Bluetooth receiver #50-14824. Provide with Extron AS141 isolation transformer.

C. Cable/Hardware
   1. Jacketed Speaker cable, West Penn 227. 12 AWG UTP
   2. Jacketed Microphone/line and powered speaker cable, West Penn 291, 22AWG TSP
   3. Jacketed Antenna cable, West Penn 813, RG58A/U
   4. Jacketed CAT6 cable, West Penn 4246
   5. Supply all structural support as required for safe and properly oriented speaker arrays.

D. Music platform floor box
   1. Ace Backstage ISO104BBX backbox with provisions for 120VAC power with Ace Backstage 124SLBK floor box cover. Receptacle compliment: Four each XLRF mic outlets, one each Switchcraft EH35MMSSCB 3.5mm Auxiliary input. Provide 1-RJ45 feed through receptacle for building data and one 120VAC duplex receptacle outlet. Qty 1.

E. Touch screen control panels
   1. In the Commons, provide the following mounted in a Whirlwind #WFFD12x1KIT enclosure:
      a. (1) TLP PRO 725M Extron Touch Panel
      b. (1) Switchcraft EH35MMSSCB 3.5mm connector
      c. (1) Neutrik XLRF Auxiliary receptacle with Extron ASA141 summing transformer
      d. (1) Neutrik NE8FDV-B RJ45 receptacle.
      e. Enclosure back box; 12x12x4 flush.
   2. In the Competition Court #1 Court, provide the following mounted in a Whirlwind #WFFD12x1KIT enclosure:
      a. (1) Extron 725M Touch Panel
      b. (1) Switchcraft EH35MMSSCB 3.5mm connector
      c. (1) Neutrik XLRF Auxiliary receptacle with Extron ASA141 summing transformer
      d. (1) Neutrik NE8FDV-B RJ45 receptacle.
      e. Enclosure back box; 12x12x4 flush.
   3. AV System components
      a. Blu-Ray Player: Provide a media player capable of Blu-ray disc, DVD, CD, USB device playback format. Player shall have Panel Lock and IR remote lock functions to prevent unwanted or accidental operation. RS-232 and IP control capability
      b. XLR balanced audio output
      c. Blu-ray player shall be Denon DN-500BD. Provide Qty 1 in equipment rack.

d. Competition court 1 & Commons AV Wall Input Transmitter and Projector Receiver

4. Provide Extron DTP T UWP 232D 2 gang wall plate transmitter with VGA w/audio and HDMI inputs for connection to the Extron DTP CrossPoint 108 4K IPCP SA (60-1381-22A) switcher specified elsewhere
5. Provide an Extron DTP HDMI 4K 330RX receiver at the Owner Furnished and Installed projector

F. Program source
   1. The Solid State Media Player shall play content from SD / SDHC, USB / HDD, 3.5mm and pair up to eight (8) Bluetooth devices. The player shall have an all-metal housing and chassis and be a 1 RU rack mounted device.
   2. Model: Denon Pro DN-F350 or current model.

G. Mounting bracket for OFCI long throw projector: Chief PG1AW (white) projector guard mounted to dual stud wall bracket (white) to match guard.

2.14 LABELS

A. All microphone and auxiliary outlets shall be identified with engraved phenolic nameplates permanently and securely affixed to the device plate. All controls in the main equipment cabinet and on the remote-control panel will be correspondingly labeled.

PART 3 - EXECUTION

3.1 GENERAL

A. Reference specification 27 4100 Sound System General Provisions, part 3.

B. Microphone cable shall be twisted pair #20 gauge with a drain wire and overall foil jacket. Microphone cable shall be run in a separate conduit.

C. Speaker cable shall be twisted #14 gauge cable with overall jacket. Speaker lines shall be run in a separate conduit.

D. The above cabling shall be spliced only in junction boxes, device boxes, or terminal cabinets. In-line splices are not permitted.

E. A central terminal cabinet shall be provided. All wiring within the cabinet shall be identified by number, neatly laced and terminated.

END OF SECTION 27 41 72

SECTION 27 50 00 - COMMUNICATION UTILITY SERVICE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This section is a Division 26 Basic Materials and Methods section and is part of each Division 26 section.

B. Drawings and General Provisions of contract, including General and Supplementary Conditions, Division 01 Specification sections and all Division 26 sections, apply to work of this section.

C. Section 26 05 26: Grounding.

1.2 DESCRIPTION OF WORK

A. Provide all material and labor required to bring the serving communications company cables to the point of demarcation within the building.

B. Coordinate the service conduit installation and inspections with Franklin PUD.

PART 2 - PRODUCTS

2.1 MATERIAL REQUIREMENTS

A. Service and Distribution Backboards: ¾" plywood (AD grade), painted with two coats of non-conductive white fire-retardant paint. Size shall be 4'x8' mounted horizontally on the wall indicated on drawings.

B. Underground Service and Spare Conduit: DB-100/60 PVC, UL Listed for direct burial and Schedule 80 PVC or GRS pole risers.

C. Service Conduit Sweeps: Minimum 36" radius PVC.

D. Pull Tape: Provide a measured pull tape with a minimum 200 lbs pull strength.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Immediately after the start of construction, the contractor shall contact Franklin PUD and schedule a pre-construction meeting to verify the utility requirements, routing and schedule.

B. Provide the following drawings to Franklin PUD:
   1. One building power/systems plan indicating the location of the communications facilities demarcation in MDF room.
   2. One electrical site plan indicating underground service routing and handhole locations.

3.2 UTILITIES

A. It shall be the contractor's responsibility to coordinate and confirm all aspects of the utility service. work to the building with the serving utility companies listed below. The contractor shall verify the requirements indicated on the documents are accurate and meet all utility requirements prior to beginning any utility work.

B. The serving utility companies are as follows:
   1. Fiber: Franklin PUD; 509-542-5366, Brent Weatherman, bweatherman@franklinpud.com

3.3 RIGHT-OF-WAY EASEMENT

A. PSD shall grant to Franklin PUD a valid right-of-way easement.

B. The contractor shall coordinate the right-of-way easement with Franklin PUD and PSD.

3.4 UNDERGROUND SERVICE

A. Conduit shall be placed at a minimum depth of 36". No more than a total of 360° of bends in any one conduit run. To avoid installation difficulties, curves or bends in excess of 90° in the entrance conduit are not acceptable. In runs over 300', bends must be metal or fiberglass to prevent being burned through due to friction from the winching rope. Runs over 300' may need additional stub-ups for pulling purposes. Check with the Franklin PUD representative for exact locations as applicable.

B. Provide 4" DB-100/60 (DB) PVC conduits under driveways, curbs or parking lots as designated within the confines of the project.

C. The PVC conduit prior to paving or the placement of curbs.

D. The service conduit will remain the property of PSD. The fiber service cable will remain the property of Franklin PUD.

E. The service conduit shall be dedicated for communications use only.

F. Maintain clearances from electrical, gas, water, sewer and other utilities as required by all utilities where structures are located in a common trench or where they cross. Maintain a minimum 12" separation from electric power and gas utility lines.

G. All conduit stub-up locations must be tightly clustered and be configured to fit in Franklin PUD vault. All conduits to contain required pull line.

H. All conduits must be free of foreign materials. All PVC joints must be glued.

I. All conduit set at walls will be flush against them and secured with 'U' clamps or Unistrut and clamps.

J. Identify each end of the service conduit as 'Franklin PUD Fiber'.

K. Seal the inside and outside conduit to prevent rodents, water or gases from entering the conduit. Use rubber conduit plugs, a water plug, or duct sealer, depending upon the conditions.

3.5 DEMARCATION POINTS

A. General:
   1. The point of demarcation will be located at the Minimum Point of Entry (MPOE) of the building. The communications demarcation (FCC Part 68) is defined as the point of interconnection between the communications network facilities and the customer owned deregulated wiring and equipment.
   2. Provide a horizontally mounted 4'x8' plywood backboard treated with fire retardant or painted with a non-conductive fire-retardant white cover coat. The backboard should be permanently attached to the wall. The top of the backboard shall be placed at 6'-0" above the floor. Conduits for communications cables shall be stubbed up to 2" above finished floor at the lower left corner of the backboard.
   3. Supply and install plywood backboards in utility/equipment rooms, as indicated on drawings for the installation of all Franklin PUD fiber inside demarcation equipment requirements.

3.6 PRE-SERVICE WORK REQUIREMENTS

A. Before Franklin PUD fiber service can be provided the contractor shall perform all of the following items and do so at no expense or penalty to Franklin PUD.
   1. Final grade must be established before pedestal housings are placed. If final grade is changed after the pedestal is set and requiring the pedestal to be reset, the contractor will be responsible for all costs incurred.
   2. Mark all necessary property lines and corner points to insure the proper location of communications facilities within the utility easement.

3. Backfill excavations around the footings, foundations and walks that conflict with the location of the proposed communications facilities.
4. Locate at the time the proposed communications facilities are staked-all private facilities (water septic, private electric lines and gas lines).
5. Provide any development revisions or changes in the approved site plans that would affect the proposed installation of communications facilities.
6. Provide access (conduit) for cable placement from property line to demarcation backboard.
7. Franklin PUD provide all fiber cables and terminations.
8. The Contractor shall bear all costs associated with the relocation of proposed facilities due to grading or backfilling. Any Franklin PUD facilities damaged after being installed shall be replaced at the expense of the Contractor.

B. Provide the Franklin PUD construction representative with a minimum two week notice prior to trench backfill, after conduit is installed for inspection.

C. Provide the Franklin PUD construction representative with a minimum two week notice prior to installation of cable once conduits and backfill is in place.

END OF SECTION 27 50 00

SECTION 27 5123 - IP INTERCOMMUNICATION CLOCK SYSTEM

PART 1 - GENERAL

1.1 SYSTEM REQUIREMENTS

A. This section includes general administrative and procedural requirements related to the IP intercom and bell system for the Pasco School District.

B. The provisions of the agreement, including bonds and certificates, the General Conditions and Division 01 specification sections apply to all work of this section.

C. The general intent of this specification is to provide system integration of a school intercommunication and program system to the school IP telephone system. The intercommunication and clock system shall provide all the features specified such as voice prompting, normal and emergency call-in, dial-up two-way loud speaking intercommunications and audio paging as well as a master clock system with class change signaling and secondary clock correction. All speakers to be IP.

D. The system shall be of modular design to facilitate both expansion and service.

E. Provide IP intercom speakers, wireless clocks, backboxes, and cabling from device to telecommunications room, for connection to the existing school district wide, Cisco VoIP intercommunication/master clock system. The School District Cisco telephone system utilizes Singlewire, Informacast software.

F. Network servers, software and programming are provided by the owner.

G. All major components shall be listed with the Underwriter's Laboratories Re-examination Service or other NRTL. Network connected telephone equipment shall be listed under UL 1459.

H. The system shall include all rough-in including cable and jacks provided under 27 15 00. Open air cable shall be plenum rated and meet the specifications of section 27 15 00.

I. The system infrastructure shall be designed for school applications and shall be completely factory-assembled, wired and tested by a manufacturer of established reputation who has and can refer to similar school communication systems which are currently installed and operating satisfactorily.

J. All major intercommunication system equipment shall be supplied and installed by an authorized factory distributor. The intercommunication system contractor and manufacturer shall have furnished and installed similar systems for school applications.

K. The intercommunication infrastructure system contractor shall furnish and install all materials, even though not specifically mentioned herein, which are necessary for the proper integration of the system so that the system shall perform the functions listed herein in compliance with all the specified requirements.

L. The systems central switching exchange shall be registered with the FCC for connection to the switched telecommunications network. Submit FCC registration number of the proposed system on separate documentation.

1.2 CONTRACTOR QUALIFICATIONS

A. The communication system contractor shall guarantee availability of 24-hour local service by factory trained personnel of the equipment manufacturer. The distributor shall have available stock of the manufacturer's standard parts.

B. Communication system contractor shall be located within 150-mile radius of the installation.

C. All components of the installed system shall be sold, supported and installed by a single systems contractor. This contractor shall be responsible for the coordination of the various components into a smooth integrated system. The Contractor shall be factory trained for the equipment being installed.

D. The contractor shall be licensed and bonded and possess a valid Washington State Electrical Contractor's License and Administrator's Certificate as described in the Revised Code of Washington State. Where required by Washington State Department of Labor and Industries work is to be performed by a holder of a current State of Washington Specialty Electrician for limited energy systems.

E. The contractor providing this system shall have a minimum of five continuous years of experience furnishing and installing the equipment specified in this section. The contractor upon request shall provide a list of projects, including references.

F. Vendors pre-approved to bid and provide the equipment specified in this section are as follows:
   1. Ednetics, Inc
      971 S. Clearwater Loop
      Post Falls, ID 83854
      (208)777-4709
   2. Evco Sound and Electronics Inc.
      3511 E. Trent Ave
      Spokane, WA 99202
      (509)535-8718
   3. Interwest Technology Systems
      2027 Snyder St.
      Richland, WA 99354
   4. Dimensional Communications
      1220 Anderson Rd.
      Mount Vernon, WA 98274
      (360)424-6164

G. Approval of other systems vendors must be requested prior to bid and approved by addendum. The owner shall have first right of refusal for any proposed alternate manufacturer or vendor. Provide proof of certifications, project references and other information indicated in paragraphs A-D above.

1.3 DESCRIPTION OF WORK

A. This specification describes the speakers, clocks, and system connections required to connect directly to the District IP Intercom system via the school Local Area Network (LAN). The intent of this specification and work required is for the contractor to provide and install IP intercom and clock components infrastructure connecting back to the LAN.

B. The Contractor shall provide all digital speakers, in accordance with the operational characteristic and functional requirements as shown on the prints and described herein.

C. The contractor shall furnish and install all materials, even those not specifically mentioned herein, which are necessary for a complete operational system integration per the manufacture specifications so that the system shall perform the functions listed herein in compliance with all the specified requirements.

D. The contractor shall provide all rough-in and other cabling and devices shall be provided by the contractor, including but not limited to; IP speakers and cabling, IP intercom clock speaker combination devices, exterior loud speakers, specialty back boxes, and conduit rough ins., wiring, etc. back to closets as designated. Provide Software (unless existing customer) and programming of all end-point devices.

E. Documentation of all MAC addresses and locations shall be submitted to the district on their supplied spreadsheet by the installer prior to the final approval.

F. OFOI items: Informacast licenses, software, servers & programming.

1.4 SUBMITTALS/SHOP DRAWINGS

A. Prepare and submit product information in accordance with sections 03 3300 and 01 7700 as appropriate.

B. Complete package submittals shall be submitted at one time to the Owner Representative for approval. Partial submittals will not be considered.

C. IP Intercom Clock System Pre-Construction Submittal:
   1. Submit in booklet form, with data arranged under basic categories, i.e., Personnel, Products, etc.
   2. Submittal shall include a typewritten index.
   3. Submittal shall be organized by specification sections and paragraphs 2.1, 2.2, etc.
   4. Submittal shall be clean legible documents in electronic PDF format. Scanned and/or poor-quality documents shall be rejected.
   5. The submittals shall be organized and divided into components for each system and referenced to section of the Specifications.
   6. Submit product data information sheets for approval and coordination with the item or model to be used clearly marked, showing ratings where appropriate.
   7. Provide a spreadsheet summary indicating the workstation device labeling identification for each IP-based intercom speaker digital clock combination device, the associated room or space number, a column for the device serial number, the MAC address and the I P address. The Owner shall provide the IP address information.

D. Shop Drawings: The system contractor shall provide AutoCAD drafted shop drawings and files for submittals and Record (As-Built) Drawing purposes. The shop drawings shall include the MAC address for each IP device provided.

E. Provide Shop Drawings showing equipment locations and routing of cables and wiring in conduits and raceways where they differ from the project drawings. Shop drawings shall indicate cable types and sizes, routing, connection points, equipment locations, point numbers, and equipment addresses, and other such information.

F. Approved shop drawings shall be used as plan for system installation.

1.5 PRIOR APPROVAL REQUESTS

A. Substitutions: The substitution of products will be considered under the terms and conditions of this Section.

B. Request to bid products other than those specified shall be submitted in writing no later than ten days prior to bid. The request shall be accompanied by descriptive literature, catalog data, one-line diagrams of system components and interface wiring diagrams of head-end components. Additional material shall be provided upon request.

C. Product Submittals: Prior to ordering or installation, the systems contractor shall submit the following material for the Architect's/Engineer's approval:
   1. Catalog data of all major components
   2. Equipment specifications
   3. Riser and/or wiring diagrams indicating zoning, numbering, wiring layout, equipment interconnect, etc.

1.6 CLOSEOUT SUBMITTAL

A. Record (As-Built) Drawings/O&M Material: The system contractor shall furnish manufacturer's manuals of the completed system, including individual specification sheets, schematics, inter-panel and intra-panel wiring diagrams. In addition, all information necessary for the proper maintenance and operation of the system must be included.

B. Post bid shop drawings shall be updated with any changes made during construction.

C. Upon completing the project contractor will be required to deliver as-built drawings and O&M manuals to the customer prior to final acceptance.

D. Where any material, equipment or system component is installed differently from that shown, the difference shall be indicated clearly and neatly using ink or indelible pencil in red during construction.

E. Ten (10) days prior to the substantial completion date for the facility, provide an electronic set of record drawings, incorporating all changes during construction. Record drawings shall include the data port identification label, IP intercom clock serial number, IP intercom address and I P intercom clock MAC address. Submit the record drawings to the Owner's Representative.

F. Architectural x-reference backgrounds shall be bound to each drawing file. Request the final architectural background drawing files that incorporate any floor plan and program spaces numbering modifications or other related information pertinent to the Owner.

G. Provide an electronic copy of the record drawings.

1.7 PRE-INSTALLATION MEETING

A. The intercommunications system provider shall attend a pre-installation meeting upon request of the contractor or owner’s representative.

B. The purpose of this meeting is to coordinate the installation responsibilities of the contractor and other related systems providers (i.e. Telecommunications) and to verify material locations indicated on the documents can be achieved.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. The equipment listed in the product section will describe the Basis of Design equipment. It shall be the contractor’s responsibility to review the bid documents and provide all materials required (whether specifically identified or not) for a complete installation. All products listed must conform and provide all features and functions listed within this specification.

2.2 IP INTERCOM CLOCK COMBINATION DEVICE WITH FLASHER

A. Intercom digital clock speaker shall be IP enabled with an RJ45 connection and shall be powered utilizing Power-Over-Ethernet (PoE). The speaker shall have an internal microphone with the capability for two-way communication utilizing an omni-directional subminiature electret condenser microphone. The device shall contain a factory assembled loud speaker and 3" LED readout Each IP Intercom Clock shall have three flashers configurable for emergencies alerts and have individual control.
   1. Manufacturer: Advanced Network Devices (AND)
      a. IP Devices:
         1) IPSWD-RWB (JP Speaker with Display and Flashers) (Classroom Speakers)
         2) IPCDS-RWB-U (Double Sided Clock with Brackets and Red, White, and Blue Flashers) (Hallway Clocks w/Speakers)
         3) I PCSL-W-R WB (IP Clock Large with White Display and Red/White/Blue Flashers) (Auditoriums)
         4) I PCSS-RWB (Small IP Clock with Red, White. and Blue Flashers) (For Offices)
         5) Advanced Network Devices clock/intercom #IPSIGNL-RWB (Gym & Dining Areas)

      b. Back Box /Frame Options:
         1) IPS-FM1 – Flush Mount (For the IPSWD type devices). Flush mounting is preferred. However, when cost and/or aesthetics prohibit flush mounting, contractors may surface mount devices upon district approval.
         2) IPS-SM1 – Surface Mount (IPSWD type devices)

2.3 I P I NTERCOM - OUTDOOR RATED SPEAK ER

A. Intercom speaker shall be IP enabled with an RJ45 connection and shall be powered utilizing Power-Over-Ethernet (PoE).
   1. Manufacturer: Advanced Network Devices (AND)
   2. IP Devices:
      a. I PSWS-SM-0 (Back Box Included) Outdoor Speaker.

2.4 WEATHER PROOF VAN DA L RESISTANT SPEAK ER/TRA NSFORM ER

A. The loudspeaker shall be of the flush mount weatherproof type. All exposed metal parts shall be heavily plated and sealed.

B. The loudspeaker shall have a full range audio power rating of 15 watts. A rubber gasket for providing a weatherproof seal between speaker flange and mounting surface shall I be furnished.

C. The loudspeaker shall have an integral transponder capable of delivering is full rated power within +I dB, 1OOHz to I 0 kHz. The primary taps shall have power taps of 5, 2.5, 1.25, .625, and .3I 25 watts. The secondary impedance shall I be 8 ohms.

D. Manufacturer: Atlas Sound, Part #APF- I 5T

2.5 VAN DA L-PROOF EXTER IOR GRJ LLE/ENCLOSURE

A. Provide vandal-proof exterior speaker grille. The square front of the grille shall be manufactured from a special self-aging aluminum alloy which has a tensile strength of 44,000 psi. each grille shall have a heavy gauge cold-rolled steel perforated screen to protect the speaker from vandal damage. The four mounting holes shall be countersunk.

B. The grille shall be furnished with tamper-proof hardware to prevent unauthorized entry to the grille interior. The finish of the grille shall be textured white epoxy with a heavy gauge steel flush enclosure.

C. Manufacturer: Atlas Sound
   1. Vandal-Proof Grill: Part #VP161A-APF
   2. Flush Enclosures: Part # 161RES

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all clocks and speakers in flush back boxes in new framed wall construction.

B. Provide surface enclosures for devices located on masonry walls.

C. Exterior installations shall be made watertight.

D. Provide labels indicating the MAC address on the face of the IP clocks and speakers.

E. Prior to installation, the contractor shall initiate a meeting with the owner, project manager, IT representative and all sub-contractors involved with the installation of this system. The purpose of this meeting will be to identify the zoning areas and layout to provide maximum flexibility in future re-arrangement to the system.

F. Telecommunications contractor shall be responsible for any building repairs made necessary by their work or caused by negligence of their employees. No cutting, notching, drilling or altering of any kind, shall be done to the building without first obtaining permission from the Owner.

G. The owner may have other contracts in connection with this work for the installation of software and equipment for intercom, clock, data and voice applications. The contractor shall provide other Trade Contractors reasonable opportunity for the introduction and execution of their work and shall properly coordinate other trade's work with theirs as required.

H. Unless otherwise specified, legal and procedural conditions for the performance of work shall be consistent with those published in A IA Document A20 I - "General Conditions of the Contract for Construction".

3.2 WIRING METHODS

A. All cabling shall be run exposed as "open cabling" in ceiling spaces and ceiling plenums. Provide all hanger supports and cabling supports for cabling specified in this section. All support structures shall adhere to the requirements in the National Electrical Code.

B. Open cable shall be supported with their own support system. Attachment to ceiling grids, ductwork, piping, conduit, etc. is prohibited.

C. Open cabling support shall be provided by cable tray or J-Hooks or D-Rings spaced a maximum of 5’-0” O.C.

D. Cabling bundles shall not sag more than two inches from the bottom of the cable supports.

E. Cable bundles and supports changing pathway direction shall I maintain proper bend radius as to not impact the physical jacket construction of the cable. Cabling that become damaged during this transition, shall be replaced in their entirety.

F. Installers shall observe the applicable requirements and recommended good practices contained within ANSI TIA-568-C. I -"Cabling Installation Requirements."

G. All cabling shall be bundled using riser or plenum rated tie-wraps at mid-span based upon the type of cabling required.

H. Provide CAT 6 plenum rated cable for IP devices under specification section 27 1500. These cables shall be home run from each intercom/digital clock.

I. Provide EMT conduit for the Gymnasium and Multi-Purpose room or in any other area where there is no ceiling (Exception: Mechanical Mezzanines).

J. Provide patching for IP intercom & clock cabling utilizing 12” orange patch cords. Owner shall provide patching from the Ethernet PoE switch to the IP intercom clock patch panel in the telecommunications room. See contract drawings for exact quantities and locations.

K. Provide to the Owner with a complete and updated summary spreadsheet matrix. The spreadsheet shall contain the information as submitted in Paragraph I.3 with the IP intercom clocks serial number and MAC addresses. The completed matrix shall be provided to the Owner 45 days prior to the substantial completion date.

3.3 FIRESTOPPING

A. All cabling running through rated floors and walls shall be fire stopped in accordance with the requirements within this Section.

B. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure).

C. Any penetrations created by or for the contractor and left unused shall also be sealed as part of the contractor's scope of work.

D. Firestop putty or pillows shall be used inside conduits and cable trays to provide a re-enterable system which allows easy removal or entry of cables in the future while still maintaining the fire protection rating.

E. Firestop systems shall be U L Classified to ASTM E814 (UL 1479).

F. All firestop systems shall be installed in accordance with the NEC and the manufacturer's recommendations and shall be accomplished in a manner acceptable to the local fire and building authorities having jurisdiction over this work.

3.4 SYSTEM INTERGRATION

A. Provide coordination as required for the configuration and setup of each clock device and IP intercom speaker digital clock device with the Owner's vendor for a complete and operational system.

B. Contractor shall be required to participate in the testing and commissioning with the Owner's vendor for system predominance, sound level continuity and quality, clock digital display quality, and shall participate fully in the resolution of any issues.
   1. Speakers shall be configured and/or adjusted to comply with the following audio levels: Classrooms shall have a consistent decibel setting and shall be verified that they are performing equally based upon the software configuration.
   2. Corridors shall have a decibel setting of 93dB at 1w - 1m.
   3. School entries and foyers shall have a decibel setting of 93dB at 1w – 1m.
   4. Commons and multi-purpose room spaces shall have a decibel setting of 93dB at 1w – 1m.
   5. Gymnasiums shall have a decibel setting of 93dB at 1w – 1m.
   6. Libraries shall have a decibel setting of 93dB at 1w – 1m.

3.5 LABELING

A. General
   1. Labeling shall be in accordance with ANSVTIA/EIA-606A, Administration Standards for Commercial Telecommunications Infrastructure.
   2. All labels shall be permanent typewritten labels produced by a labeling machine.
   3. Labels shall be installed on all cables at each end. Ensure labels are securely fastened
   4. All labels shall be within 6-inches of cabling termination and placed so they can be easily read.
   5. Labeling information will be reviewed at the Pre-Construction Meeting.
   6. All labeling shall be completed prior to the substantial completion date of the project.

B. IP Intercom Speaker Clock Grille Labeling: Provide a label on each IP Intercom speaker clock located on the front lower left side of the grille. The label shall be machine generated and be identical to the telecommunications device labels.

3.6 WARRANTY

A. A five-year manufacturer's warranty covering all components, equipment, and software shall be submitted in writing with system documentation un less otherwise noted in the project specifications.

B. The warranty period shall begin on the system 's first use by the school.

C. A three-year warranty on the installation of the system shall be submitted in writing with system documentation. Should any trouble develop within this period from the date of acceptance of the work, the contractor shall properly make all required connections without cost to the owner.

END OF SECTION 27 51 23

DIVISION 28 – FIRE ALARM AND SECURITY

DIVISION 29 through DIVISION 30 – not used

SECTION 28 0010 - GENERAL PROVISIONS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the contract, including General and Supplementary Conditions, Division 01 Specification sections, apply to this section.

1.2 SUMMARY

A. Section includes:
   1. Definitions and Abbreviations
   2. Contract documents
   3. Code requirements
   4. Permits & fees
   5. Submittal requirements
   6. Prior approval requests
   7. Warranty
   8. Construction phasing
   9. Project closeout requirements

1.3 DEFINITIONS

ADA	Americans With Disabilities Act
Ampacity	Capacity expressed in amperes
ASTM	American Society for Testing & Materials
Concealed	Hidden from sight as in trench, chases, slabs, furred spaces or ceilings
Contractor	Shall mean the General Contractor who signs the contract with the Owner
EMT	Electrical Metallic Tubing
Exposed	'Not concealed' as defined above
Furnish	Supply
IBC	International Building Code
IFC	International Fire Code
IEEE	Institute of Electrical & Electronic Engineers
IPCEA	Insulated Power Cable Engineers Association
Indicated	Indicated on drawings
Install	Install or apply
Mfg.	Manufacturer
NBFU	National Board of Fire Underwriters Pub. 70 (latest edition)
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Testing Lab
Provide	Furnish and install
UL	Underwriters Laboratories, Inc.
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety Health Act

1.4 GENERAL SCOPE OF WORK

A. It is the intention of the Division 28 Contract Documents to provide complete and fully operational limited energy systems for telecommunications cabling, audio/visual, sound reinforcement, intercom, master clock and communications hereinafter specified and/or as shown on the drawings. The work shall include all materials, appliances and apparatus not specifically mentioned herein or noted on the plans, but which are necessary to make a complete working installation.

B. Reference the Technology system matrix at the end of Division 28 for owner provided materials.

1.5 CONTRACT DOCUMENTS

A. It is the intention of the Division 28 Contract Documents to provide complete and fully operational limited energy systems for security and life safety; intrusion detection, access control, video surveillance and fire alarm hereinafter specified and/or as shown on the drawings. The work shall include all materials, appliances and apparatus not specifically mentioned herein or noted on the plans, but which are necessary to make a complete working installation.

B. All limited energy systems, mounting hardware, labor and other items indicated on the Division 28 drawings, schedules and/or in the specifications shall be included in the Contractor's bid, unless specifically indicated otherwise. The specifications, schedules, diagrams, details and plans are complementary and what is indicated on any is as binding as if indicated on all. Where a conflict exists between what is shown and what is specified, the more stringent shall govern.

C. The contract drawings indicate the extent and the general character and approximate location and arrangement of material and equipment. The documents do not necessarily show the total number of conductors, raceways, boxes, support, access panels, actual routing, block outs, cable sleeves, exact device or equipment locations or other such detailed information for the work required. The Contractor shall provide all necessary materials as required by applicable code and product specification for a complete and fully operational installation in accordance with the true intent of the drawings and specifications.

D. The Division 28 documents do not separate work or responsibilities of sub-contractors. The General Contractor is responsible for defining the scope of work of each contractor. This specification recognizes only one contractor. That is the General Contractor who signs the contract with the Owner. Where the term 'The Contractor' is used, it applies to the contractor responsible for the installation of the work described.

1.6 CODES

A. The installation of this work shall comply in every way with the requirements of the laws, ordinances and rules of the State of Washington, the National Board of Fire Underwriters, the National Electrical Code, WISHA and the City of Pasco, WA.

B. If any conflict occurs between these rules and this specification, the rules shall govern. Nothing in these drawings and specifications shall be construed to permit work not conforming with governing codes. This shall not be construed as relieving the Contractor from complying with any requirements of the plans or specifications which may be in excess of requirements of hereinbefore mentioned rules and not contrary to same.

1.7 PERMITS & FEES

A. Obtain and pay for all licenses, permits, registration fees and inspections required by laws, ordinances and rules governing the work specified herein. Arrange for inspection of the work by inspectors and give the inspectors all necessary assistance in their work of inspection.

B. The Division 27 bid shall include all Labor and Industries permit, inspection, licensing, registration or any other fees associated with the work specified under this Division.

1.8 SUBMITTALS

A. It is understood that before the manufacture or installation of any of the work under this contract is carried forward, shop drawings of such work shall be submitted for review.

B. Submittals shall be provided in accordance with specification Section 26 0010.

C. The Contractor shall provide quantities of submittals and shop drawings as required by Division 01. The Owner, Architect and Electrical Engineer will retain a minimum of one set each.

D. Shop drawings shall be submitted in ample time to avoid delay in any of the work. Items requiring immediate attention due to long lead delivery time or for early construction rough-in, are to be identified and may be submitted separately in advance of the remainder of the submittal binders. The review of these items will be expedited.

E. The Architect and Engineer's review of the submittals/shop drawings is intended as a check for general conformance with contract documents only. Failure by the Architect or Engineer to discover an error on a submittal does not relieve the Contractor of the responsibility for compliance with requirements of the drawings and specifications.

F. Upon request from the Architect or Engineer, provide material samples for examination, color selection and/or quality control. These samples shall be delivered to the Architect's or Engineer's office as directed.

G. Prior to forwarding to the Architect, the Contractor shall review the submittals, mark them with their comments, corrections and approval stamp. The Contractor shall verify that all of the specified requirements are indicated and ensure that the intended items have been identified on the submittal. Submittals shall be clearly marked as to which items, options, colors, models, etc. are being provided. Only the items marked or indicated will be considered as being submitted. If no marks or indications are present on a page, then it will be assumed that nothing applies to this project and the submittal will be rejected. Indicate additional information necessary for the Architect and Engineer to determine the Contractor's intention, such as the method of feeding panelboards (top or bottom), color selection, equipment options, etc.

H. For material requiring color or finish selection 'by Architect', provide separate copies marked 'ATTENTION (ARCHITECTS NAME) – COLOR/FINISH SELECTION REQUIRED'.

I. Provide brochures and shop drawings on the following materials:
   1. Extra voice/data receptacle log with fair cost estimate
   2. Fire Alarm System
   3. Security Intrusion System
   4. Security Access System
   5. Video Surveillance System

1.9 PRIOR APPROVAL SUBSTITUTION REQUEST

A. Items specified are basis-of design and intended to represent quality and general requirements. It is not the intent of these specifications to prohibit other manufacturers from submitting on substitute materials for review as an acceptable equal. Approval granted for substitution requests is made under the assurance that the manufacturer, vendor or sales representative guarantees that the substituted product meets or exceeds the minimum requirements of the specified product.

B. To ensure ample time for review, evaluation and publishing (by addendum), substitution requests must be submitted no later than ten normal business days prior to the bid. Submittals received less than ten normal business days will be at risk of not being published and allowed to bid.

C. Vendors seeking prior approval shall include system certifications in their submittal.

D. If prior approval has not been requested and granted, then the product manufacturer shall be as specified in the contract documents. The Architect/Electrical Engineer reserves the right to reject any product that has not been prior approved or specified.

E. The Contractor shall be responsible for checking equipment dimensions of proposed substitute equipment and be responsible for it fitting the space allowed.

F. Approval of substitution requests are granted with the understanding that any additional cost involved with the installation, re-design or replacement of the substituted material (as a result of the unacceptable performance of that product) shall be paid for by the Contractor.

G. Approved substitutions will be listed in Addenda. Any item listed by addenda may be provided under this contract.

H. Substitution after the bid will only be allowed for any one of the following reasons:

1. The Architect, Engineer and Owner approve the substitute product as a better product, at no increased cost.
2. The substitute product is approved as an equal by the Architect, Engineer and Owner and a credit is offered to the Owner. Reference Division-1 documents for substitution request procedures.
3. The reason for unavailability is discontinuance by the manufacturer.

1.10 SCHEDULE OF VALUES

A. Within 30 days of the Notice to Proceed the Contractor shall furnish a breakdown of the Division 27 work as indicated in the following Schedule of Values:
   1. Mobilization
   2. Closeout
   3. Security Access Control/Intrusion System, Material
   4. Security Access Control/Intrusion System, labor
   5. Security Intrusion System, Material
   6. Security Intrusion System, labor
   7. Video Surveillance, Material
   8. Video Surveillance, labor
   9. Fire Alarm System, Material
   10. Fire Alarm System, Labor
   11. DAS signal strength testing and rough-in (base bid)

1.11 GUARANTEE

A. This Contractor shall guarantee the satisfactory operation of all material, equipment and installations provided under this specification. Make good, repair or replace, as may be necessary, any defective work, materials or equipment which fail or become defective within one year after date of Owner occupancy. The beginning of the warranty period is to be determined by the Architect at the time of substantial completion.

B. Provide extended warranty for the voice/data communications cable backbone (Premise Wiring) system: fifteen years (material and labor).

PART 2 - PRODUCTS

2.1 GENERAL MATERIAL EQUIPMENTS

A. All materials shall be new and must be equal to the quality herein specified and as shown on the drawings or a reviewed and accepted equal.

B. Reference the Technology Component System Matrix following the Division 28 specifications for an outline of materials that are CFCI, OFCI & OFOI.

C. All materials shall be the standard products of manufacturers regularly engaged in the production of such equipment and shall be the manufacturer’s latest standard design and shall be manufactured in accordance with applicable standards of NEMA, ANSI or UL.

D. All material, equipment and devices shall be listed by Underwriters Laboratories, Inc. and shall be manufactured for use with the system specified and the intended application.

E. Provide the materials specified unless a product has been discontinued or revised in which case provide the manufacturer’s equivalent product replacement.

F. Materials and equipment shall be delivered to the project and stored in original containers or cartons and shall be properly protected from the elements, theft or vandalism. Items subject to moisture damage shall be stored in dry spaces.

G. Material damaged during construction shall be replaced or repaired to the Owner's satisfaction.

H. All material shall be provided and installed per the requirements for seismic zone D.

I. All cabling provided under Division 27 shall be rated for the location installed. Cabling installed in wet locations shall be rated for such and installed in conduit the entire run. Provide metallic enclosures to splice from outside plant to riser cable in accordance with the Washington State Administrative Code.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS FOR INSTALLATION

A. Workmanship shall be of the best quality and none but competent mechanics shall be employed and shall be under the supervision of a competent foreman. All work shall be complete and present a neat and symmetrical appearance. Non-professional workmanship shall be removed and replaced if so directed by the Architect at no additional cost to the Owner.

B. All equipment and material shall be installed to comply with all applicable codes and industry standard work practice.

C. All work and materials shall be subject to inspections at any and all times by representatives of the Owner and/or Architect.

D. The documents do not show all necessary transitions, offsets, changes in direction or every pull or junction box required. Provide all boxes necessary to install work to conform to the structure.

3.2 WORK NOT INCLUDED

A. IP surveillance system VMS programming (OFOI)

3.3 PHASING & SCHEDULING REQUIREMENTS

A. Construction phasing and scheduling unless specifically indicated elsewhere in the bid documents is the responsibility of the General Contractor. The Electrical and Communications trades shall coordinate their work with the General Contractor.

3.4 MEETINGS AND FIELD OBSERVATION

A. A representative of the Electrical Consultant shall attend monthly construction coordination meetings and conduct an observational walk-through.

B. At the time of monthly walk-through, the project foreman shall (upon request) accompany the observation party, and remove cover plates, panel covers, ceiling tiles, access panels and unlock doors for the Electrical Consultant, to allow complete observation of the entire electrical system in an efficient manner.

C. The Contractor shall provide all ladders, tools, and hard hats required by the Electrical Consultant. The Contractor shall open any switchboard, panel, box, etc. as requested for the Architect/Engineer’s inspection.

D. The Contractor shall bring the red-line (mark-up) set of Record Drawings to each monthly meeting attended by the Electrical Consultant for review.

3.5 PROJECT CLOSEOUT

A. Prior to final acceptance of the project the Contractor shall provide Division 27 record drawings and operation and maintenance manuals (O&M) for all work included in this contract

B. Submittals, record drawings, O&M manuals and deliverables shall be provided in accordance with specification Section 26 0010.

C. The Contractor shall leave the job in complete order ready for use. All refuse shall be removed, all devices and equipment shall be secure, fully equipped, completely cleaned and in good working order. The owner’s maintenance & operational personnel shall be thoroughly indoctrinated in the

maintenance & operation of each system provided under this division. All spare and remaining items not used in the project but paid for by the owner shall be delivered in like new condition to an on-site storage facility as directed by the owner.

END OF SECTION 28 00 10

SECTION 28 0500 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
    1. Electronic safety and security equipment coordination and installation.
    2. Sleeves for raceways and cables.
    3. Sleeve seals.
    4. Grout.
    5. Common electronic safety and security installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 COORDINATION

A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
    1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
    2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
    3. To allow right of way for piping and conduit installed at required slope.
    4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

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

C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: Provide sleeves in accordance with the requirements of Specification Section 26 0500.

2.2 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. All material and equipment shall be installed symmetrical, level, plumb, parallel and perpendicular to other building systems and components, except where otherwise indicated.

G. Devices shall be mounted in compliance with the Americans with Disabilities Act (ADA) or as specified within the limits described below.
    1. High forward reach limits, without obstruction; between 15” and 48”.
    2. High forward reach limits, with obstruction less than 20”; between top of obstruction and 48”.
    3. High forward reach limits, with obstruction between 20” & 25”; between top of obstruction and 44”.
    4. Clear floor space, parallel approach; between 9” and 54”.
    5. Side reach over a 24” wide by 34” maximum obstruction; 46”.

3.2 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Electronic safety and security penetrations occur when pathways or cables penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.3 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 28 05 00

SECTION 28 3100 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Expandable emergency voice evacuation fire alarm system.

1.2 RELATED SECTIONS

A. Section 23 – Building Automation and Control.

B. Section 27 1500 – (Communications Horizontal Cabling).

1.3 REFERENCES

A. Electrical Industries Association (EIA):
   1. EIA-232-D – Interface Between Data Terminal Equipment and Data Circuit-Terminating
   2. EIA-485 – Equipment Employing Serial Binary Data Interchange

B. National Fire Protection Association (NFPA):
   1. NFPA 13 – Installation of Sprinkler Systems, 2013 Edition.
   2. NFPA 70 – National Electrical Code (NEC), 2014 Edition.
   3. NFPA 72 – National Fire Alarm Code, 2013 Edition.
   4. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems, 2012 Edition
   5. NFPA 101 – Life Safety Code

C. Americans with Disabilities Act (ADA)

D. Underwriters Laboratories (UL):
   1. UL 38 – Manually Activated Signaling Boxes
   2. UL 268 – Standard for Smoke Detectors for Fire Alarm Signaling Systems.
   3. UL 268A – Standard for Smoke Detectors for duct applications.
   4. UL 521 - Heat Detectors for Fire Protective Signaling systems
   5. UL 464 – Audible Signaling Appliances
   6. UL 864 – Standard for Control Units and Accessories for Fire Alarm Systems.
   7. UL1481 – Power Supplies for Fire Protective Systems
   8. UL 1638 – Visual Signaling Appliances
   9. UL 1711 – Amplifiers for Fire Protection Signaling Systems
   10. UL 1971 – Standard for Signaling Devices for the Hearing Impaired.

1.4 SYSTEM DESCRIPTION

A. This specification document provides the requirements for the installation, programming and configuration of a complete Silent Knight IFP-2100ECS (or latest model) digital protocol analog addressable fire alarm system with integrated Emergency Communication System capabilities (ECS). This system shall include, but not be limited to, system cabinet, power supply, voice command module, microphone, built in Signaling Line Circuit (SLC), 160-character LCD annunciator, eight programmable Flexputs™, built in dual line digital communicator associated peripheral devices, batteries, wiring, conduit and other relevant components and accessories required to furnish a complete and operational life safety system.

B. The construction set drawings are intended to show the minimum design requirements, quantity and location of devices. The system vendor is ultimately responsible to verify detection coverage and provide detection and notification devices as required to meet the AHJ, IFC, NFPA and other codes adopted for the location of this facility.

C. Provide notification devices for each Acoustically Distinguishable Space (ADS) that meets code requirements for intelligibility and visual alarm coverage. Vendors providing bids to contractors shall include the cost for providing additional devices and equipment that may be required to meet all codes in effect above what is indicated on the construction documents. Vendors shall notify the contractors receiving their bids of all adjustments and additional rough-in needed for compliance.

D. General Requirements:
   1. The contractor shall furnish and install a complete 24 VDC, electrically supervised, analog addressable fire alarm system with emergency communication as specified herein and indicated on the drawings. The system shall include but not be limited to all control panels, audio amplifiers, power supplies, initiating devices, audible and visual notification appliances, alarm devices, and all accessories required to provide a complete operating fire alarm system.
   2. All fire alarm devices and cabinets shall be red.
   3. The following supervision shall be provided by a factory trained service technician from the distributor of the fire alarm equipment. The technician shall be trained and shall have a minimum of two (2) years of service experience in the fire alarm industry. The technicians name shall appear on equipment submittals and a copy of his manufactures trained shall be sent to the project engineer. The technician shall be responsible for the following items:
      a. A pre-installation visit to the job site to review equipment submittals and to verify the method by which the system is to be wired.
      b. During the installation the certified technician shall be on site or make periodic visits to verify installation and wiring of the system. He shall also supervise the completion of conduit rough, wires pulled into conduit and wiring rough, and ready for trim.
      c. Upon completion of wiring, final checkout and certification of the system shall be made under the supervision of this technician.
      d. At the time of the formal checkout, technician shall give operational instructions to the owner and or his representative on the system.

E. All equipment furnished for this project shall be new and unused. All components shall be designed for uninterrupted duty. All equipment, materials, accessories, devices and other facilities covered by this specification or noted on the contract drawings and installation specification shall be best suited for the intended use and shall be provided by a single manufacturer. If any of the equipment provided under this specification is provided by different manufacturers, then that equipment shall be “Listed” as to its compatibility by Underwriters Laboratories (UL), if such compatibility is required by UL standards.

1.5 SUBMITTALS

A. Comply with Section 01330 (01 33 00) – Submittal Procedures.

B. Include sufficient information, clearly presented, to determine compliance with the specifications and the Drawings.

C. Equipment Submittals:
   1. Cover Page: Indicate the following:
      a. Project name and address.
      b. Engineered systems distributor’s name and other contact information.
      c. Installing contractor’s name and other contact information.
      d. Date of equipment submittals. Indicate on revised submittals the original submittal date and revised submittal date.
   2. Table of Contents: Lists each section of equipment submittal.
   3. Scope of Work Narrative: Detail indented scope of work.
   4. Sequence of Operations: Use matrix or written text format, detailing activation of each type of device and associated resulting activation of the following:
      a. Control panel.
      b. Annunciator and fire drill panels.
      c. Notification appliances.

d. Building fire safety functions, including elevator recall, elevator power shutdown, door lock release, door holder release, HVAC unit shutdown, smoke evacuation system activation, and stair pressurization fan activation.

5. Bill of Material: Indicate for each component of system the following:
   a. Quantity.
   b. Model number.
   c. Description.
6. SLC Circuit Schedule: Detail address and associated description of each addressable device. Clearly provide information that indicates number of both active and spare addresses.
7. Battery Calculations: Show load of each of, and total of, components of system along with standby and alarm times that calculations are based on. Show calculated spare capacity and size of intended battery.
8. Fair cost estimate of the value associated with the specified extra materials. Breakout material and labor.

D. Shop Drawings:
1. Shop drawings shall be reviewed and approved by a registered State of Washington Fire Protection Engineer.
2. Shop drawings shall comply with the architectural drawings and NFPA 72 requirements.
3. Cover Page: Indicate the following:
   a. Project name and address.
   b. Engineered systems distributor's name and other contact information.
   c. Installing contractor's name and other contact information.
   d. Date of equipment submittals. Indicate on revised submittals the original submittal date and revised submittal date.
   e. Signed state of Washington Fire Protection Engineer's seal.
   f. Model number for Fire Alarm system basis of design.
   g. UL listings for system submitted.
4. Floor Plans:
   a. Provide separate floor plan for each floor area.
   b. Floor plan must be split using match lines to fit on the page, provide match lines and match line references that refer to sheet number that shows area on opposite side of match line.
   c. Prepare using AutoCAD.
   d. Prepare to scale 1/8 inch = 1'-0", unless otherwise required by the Architect or Engineer.
   e. Show all equipment and device locations. Indicate devices that are part of the EV/ACS.
   f. Show d/BA levels on shop drawings and rated wattage of each speaker.
   g. Indicate the ambient sound-pressure level used as a basis for design.
   h. Identify each), Acoustically Distinguishable Space (ADS) the boundaries, the method of notification in each (electronic tone, voice message or other) and whether signal intelligibility of the EV/ACS is being provided. Provide notification appliances as necessary for each ADS.
   i. Show device circuiting with a minimum of 10% spare device/power demand for future expansion.
   j. Show wiring information in point-to-point format.
   k. Show occupant notification zones.
   l. Show conduit routing, if required by the AHJ.
5. Title Block: Provide on each sheet and include, at a minimum, the following:
   a. Project name.
   b. Project address.
   c. Sheet name.
   d. Sheet number.
   e. Scale of drawing.
   f. Date of drawing.
   g. Revision dates, if applicable.

6. Control Panel: Provide sheet that details exterior and interior views of control panel and clearly shows associated wiring information.
7. Annunciator Panels: Provide sheet that details exterior and interior views of annunciator panels and clearly shows associated wiring information.
8. Graphic plan of building indicating alarm zones that match the FA descriptions displayed on the annunciators, location of electrical service and other information required by the AHJ.

E. Certification: Submit with equipment submittals and shop drawings, letter of certification from major equipment manufacturer, indicating proposed engineered system distributor is an authorized representative of major equipment manufacturer.

F. Washington State Patrol Fire Protection Bureau Submittal:

G. Provide (4) sets of Fire Alarm shop drawings to the Fire Protection Bureau, including equipment cut sheets, calculations and shop drawings. Approval must be obtained prior to the start of rough-in.

H. Prior to construction the submittal shop drawings for this project shall be submitted to the Deputy State Fire Marshal for the initial review. The drawings approved by the Deputy State Fire Marshal will then be reviewed by the City of Pasco Fire Department. Provide both a full-size hard copy and an electronic copy to the AHJ for review.
   1. Deputy State Fire Marshal:
      a. Terran Gufler
         Fire Protection Bureau – Prevention Division
         PO Box 4262
         Olympia, WA 98504-2642
         (360)596-3909
         terran.gufler@wsp.wa.gov
   2. City of Pasco Fire Department:
      a. Troy Hendron
         Fire Administration
         1011 E. Ainsworth Ave.
         Pasco, WA 99301
         (509)543-5736

I. Project Record Drawings:
   1. Submit complete project record drawings within 30 calendar days after acceptance test.
   2. Project record drawings shall be similar to shop drawings but revised to reflect changes made during construction.
   3. Upon acceptance of the updated record shop drawings, provide a 24” x 36” laminated set drawings to the owner. These drawings will be combined with Division 21, 22 & 23 laminated drawings and mounted to the wall of the room housing the FACP. See architectural specifications. Send a copy of the letter of transmittal to the project architect and engineer.

J. Operation and Maintenance Manuals:
   1. Submit complete operation and maintenance manuals within 14 calendar days after acceptance test.
   2. Operation and maintenance manuals shall be similar to equipment submittals but revised to reflect changes made during construction.
   3. Include factory’s standard installation and operating instructions.

1.6 QUALITY ASSURANCE

A. Satisfying the Entire Intent of these Specifications: It is the contractor’s responsibility to meet the entire intent of these specifications, codes adopted for the project location and providing all components for a complete system whether specified or not. Deviations from the specified products shall be at the risk of the contractor until the date of final acceptance by the AHJ, WSP State Fire Protection Bureau, architect, engineer and owner’s representative. All costs for removal, relocation, or replacement of a substituted item shall be at the risk of the electrical contractor.

B. To ensure reliability and complete compatibility, all items of fire alarm system, including control panels, power supplies, initiating devices, and notification appliances, shall be listed by Underwriters Laboratories Inc. (UL) and shall bear “UL” label and comply with the standards listed above.

C. The following supervision shall be provided by a factory trained service technician from the distributor of the fire alarm equipment. The technician shall be trained and shall have a minimum of two (2) years of service experience in the fire alarm industry. The technicians name shall appear on equipment submittals and a copy of his manufactures trained shall be sent to the project engineer. The technician shall be responsible for the following items:
   1. A pre-installation visit to the job site to review equipment submittals and to verify the method by which the system is to be wired.
   2. During the installation the certified technician shall be on site or make periodic visits to verify installation and wiring of the system. He shall also supervise the completion of conduit rough, wires pulled into conduit and wiring rough, and ready for trim.
   3. Upon completion of wiring, final checkout and certification of the system shall be made under the supervision of this technician.
   4. At the time of the formal checkout, technician shall give operational instructions to the owner and or his representative on the system.

D. Equipment, Programming, and Installation Supervision:
   1. Provide services of approved Platinum Level engineered systems distributor of Silent Knight for equipment, programming, and installation supervision.
   2. Provide proof of factory training within 30 calendar days of award of the Contract.

E. Software Modifications:
   1. Provide services of Platinum Level Silent Knight factory-trained and authorized technician to perform system software modifications, upgrades, or changes.
   2. Provide use of all hardware, software, programming tools, and documentation necessary to modify fire alarm system software on-site.
   3. Modification includes addition and deletion of devices, circuits, zones, and changes to system operation and custom label changes for devices or zones.
   4. System structure and software shall place no limit on type or extent of software modifications on-site.
   5. Modification of software shall not require power-down of system or loss of system fire protection while modifications are being made.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer’s instructions.

C. Handling: Protect materials from damage during handling and installation.

1.8 COORDINATION

A. Coordinate the Work of this section with the Work of other sections, including sprinkler systems as specified in Section 21 1313, elevators as specified in Section 14 2010, HVAC systems as specified in Division 23, and security/door locking systems as specified in Section 08 7100.

B. Coordinate the type of communications connection required with the monitoring agency selected by the owner. Communications shall be made via land line telephone, cellular or radio transmitter connections. The system supplier shall ensure that the communications are established and in place prior to the AHJ inspection for a turn key installation. The owner shall be responsible for contracting with the monitoring agency.

1.9 WARRANTY

A. Unless otherwise specified, all materials, installation and workmanship shall have a warranty for a three (3) year period. A copy of the manufacturer warranty shall be provided with the close out documentation.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Approved system manufacturer: Silent Knight (Farenhyt) by Honeywell
   1. School District standard. No substitutions allowed

B. Pre-Approved Silent Knight system providers:
   1. Camtek, 509-443-2609
   2. Allied Fire & Security, 509-624-4146
   3. Moon Security, 509-545-1881
   4. Alpine Alarm, 866-804-2698

2.2 DISTRIBUTED NETWORKED FIRE ALARM SYSTEM

A. Distributed Networked Fire Alarm System: Silent Knight IFP-2100ECS or latest model

B. References to manufacturer's model numbers and other information is intended to establish minimum standards of performance, function, and quality.

C. Substitute equipment proposed as equal to equipment specified shall meet or exceed requirements of this section.

2.3 GENERAL

A. This life safety system specification must be conformed to in its entirety to ensure that the installed and programmed life safety system will accommodate all of the requirements and operations required by the building owner. Any specified item or operational feature not specifically addressed prior to the bid date will be required to be met without exception.

B. Control Panel with Emergency Communication System
   1. The fire alarm control panel (FACP) shall be the Silent Knight IFP-2100ECS analog addressable control panel. The audio amplifiers shall be the Silent Knight ECS-50W, ECS-125W, or ECS-DUAL50W voice evacuation units. The FACP must have a 9-amp power supply and be capable of expansion to a minimum of 54 total amps via bus connected expander modules that supervise low battery, loss off AC and loss of communication.
   2. The system must contain at least one (1) Silent Knight ECS-50W, ECS-125W, or ECS-DUAL-50W watt amplifier and shall be expandable from 50 to 2000 watts utilizing up to 15 additional amplifiers. The ECS-50W and ECS-125W amplifiers shall be capable of adding a 4-zone splitter (Silent Knight ECS-CE4) to distribute the audio information to different locations in the installation. The system shall have the capability of controlling up to 40 notification zones. The amplifiers must contain the capability of being remotely located through a four-wire SBUS communications circuit and a two-wire VBUS voice circuit. The system shall have the capability of adding up to 7 ECS-RCU2000 remote command units.
   3. The voice evacuation system must have the capability of downloading fifteen (15) 60 second messages and utilize DSP technology for higher audio intelligibility.
   4. The voice evacuation system shall be capable of operating at 25vrms or 70.7vrms (ECS-50W and ECS-DUAL50W only) and must be field selectable at the amplifier level. Systems that require additional modules for voltage conversion shall not be accepted.
   5. The FACP must have Day/Night sensitivity capabilities on detectors and be capable of supporting up to 636 analog addressable points. This shall be accomplished via signaling line circuits (SLC) capable of supporting a minimum of 159 detectors and 159 module devices

each. The main panel will contain one SLC circuit with the option of utilizing 5815XL expander modules. The communication protocol on the SLC loop must be digital.

6. The FACP must support a minimum of eight programmable Flexput™ circuits. The panel must have a built in 160-character LCD annunciator with the capability of having an additional supervised remote annunciators connected in the field.
7. The FACP must have a built in UL approved digital communicator. The communicator must allow local and remote up/downloading of system operating options, event history, and detector sensitivity data.
8. The FACP must automatically test the smoke detectors in compliance with NFPA standards to ensure that they are within listed sensitivity parameters and be listed with Underwriters Laboratories for this purpose.
9. The FACP must compensate for the accumulation of contaminants that affect detector sensitivity. The FACP must have day/night sensitivity adjustments, maintenance alert feature (differentiated from trouble condition), detector sensitivity selection, auto-programming mode (Jumpstart) and the ability to upgrade the core programming software on site or over the telephone.
10. The FACP shall have a Jumpstart feature that can automatically enroll all properly connected accessories into a functional system within 60 seconds of powering up the panel. Panels that do not have these capabilities will not be accepted.
11. The main communication bus (SBUS RS485) shall be capable of class A or class B configuration with a total SBUS length of 6,000 feet.

C. System Wiring
   1. The Signaling Line Circuit (SLC) and Data Communication Bus (SBUS) shall be wired with standard NEC 760 compliant wiring. No twisted, shielded or mid capacitance wiring is required for standard installations. All FACP screw terminals shall be capable of accepting 14-18 AWG wire. All system wiring shall be in accordance with the requirements of NFPA 70, the National Electrical Code (NEC) and also comply with article 760 of the NEC.

D. Signaling Line Circuits
   1. Devices supported must include analog photoelectric, ionization smoke detectors, analog heat detectors, addressable input modules, relay output modules or addressable notification modules. Each SLC loop shall support up to 159 detectors and 159 modules.

E. SLC Loop Devices
   1. Devices supported must include analog photoelectric, ionization smoke detectors, analog heat detectors, addressable input modules, relay output modules or addressable notification modules. Each SLC loop shall support up to 159 detectors and 159 modules.

F. Analog Detector Functions
   1. The products of combustion detectors must communicate analog values using a digital protocol to the control panel for the following functions:
   2. Automatic compliance with NFPA 72 standards for detector sensitivity testing
      a. Drift compensation to assure detector is operating correctly
      b. Maintenance alert when a detector nears the trouble condition
      c. Trouble alert when a detector is out of tolerance

G. Sensitivity Function
   1. The FACP shall have the ability to set three different sensitivity levels. A zone can be programmed to a day and a night sensitivity value. The day/night schedule shall allow for 16 holiday dates that are user programmable to allow the FACP to respond at the night level on those days.

H. Programmable Flexputs™
   1. The FACP shall support eight programmable Flexput™ circuits that are capable of being programmed as supervised reverse polarity notification circuits or supervised auxiliary power circuits that can be programmed as continuous, resettable or door holder power. The circuits shall also be programmable as input circuits in class A or B configurations to support dry contact or compatible two wire smoke detectors.

I. Addressable Notification Module
   1. The contractor shall furnish and install where indicated on the plans, addressable notification modules, Silent Knight Model IDP-Control. The modules shall be U.L. listed compatible with Silent Knight's IFP-2100ECS fire alarm control panel. The notification module must provide one class A (Style Z) or class B (Style Y) notification output with one auxiliary power input. The notification module must be suitable for mounting in a standard 4 square electrical box and must include a plastic cover plate. The notification module must provide an LED that is visible from the outside of the cover plate. The notification module must be fully programmable for such applications as required by the installation. The IDP-Control shall reside on the SLC loop and can be placed up to 10,000 feet from the control or 5815XL SLC loop module.

J. Annunciator
   1. The main control must have a built-in annunciator with a 160-character LCD display and feature LED's for Alarm, Supervisory, Trouble, Silenced and Power. When in the normal condition the LCD shall display time and date based on a 200-year clock which is capable of automatic daylight savings time adjustments. All controls and programming keys are silicone mechanical type with tactile and audible feedback. Keys have a travel of .040 in. No membrane style buttons will be permissible. The annunciator must be able to silence and reset alarms through the use of a keypad entered code. The annunciators must have twenty levels of user codes that will allow the limitation of operating system programming to authorized individuals.

K. Remote Annunciator
   1. The fire system shall be capable of supporting remote annunciators. LCD Remote annunciator, Model RA-2000, shall have the same control and display layout so that they match identically the built-in annunciator. Remote annunciators shall be available in two colors, red and light gray. Remote annunciators shall have the same functionality and operation as the built-in annunciator. All annunciators must have 160-character LCD displays and must feature five LED's for Alarm, Supervisory, Trouble, Silenced, and Power. All controls and programming keys are silicone mechanical type with tactical and audible feedback. Keys shall have a travel of .040 inches. No membrane style buttons will be permitted.
   2. The annunciator must be able to silence and reset alarms through the use of a code entered on the annunciator keypad. The annunciator must have twenty levels of user codes that will limit the operating system programming to authorized individuals. The control panel must allow all annunciators to accommodate multiple users input simultaneously. Remote annunciators shall be capable of operating at a distance of 6,000 feet from the main control panel on unshielded, non-twisted cable.

L. Fire Drill Control
   1. A remote fire drill control panel shall be provided in the administration area.

M. I/O Module
   1. The fire system shall be able to support I/O modules (SK5880) that shall be used to drive remote LED graphic style displays and accommodate up to eight dry contact type switch inputs, including ECS inputs. The I/O modules shall each drive up to 40 LEDs without requiring external power connections. The I/O module inputs shall be supervised and be suitable for alarm and trouble circuits as well as reset and silence switches. The system shall also support up to 40 LED drivers that reside on the two-wire SLC loop. These driver boards shall contain 80 LED outputs that are powered by an external power source.

N. Serial/Parallel Interface
   1. The fire system shall be capable of supporting up to two serial/parallel interfaces (SK5824) that are capable of driving standard computer style printers. The interface shall be programmable for the serial and parallel ports and allow printing of events as they occur.

O. Distributed Power Modules
   1. The contractor shall supply power modules, Models RPS-1000 and 5496, compatible with the IFP-2100ECS fire alarm control panel. The RPS-1000 power module must have 6 amps of output power, six Flexput™ circuits rated at 3amps each, and two form C relay circuits rated at 2.5 amps at 24 volts DC. The six Flexput™ circuits shall have the same functionality as the

Flexput™ circuits on the main panel. The RPS-1000 shall be capable of being connected via an RS-485 system bus (SBUS) at a maximum distance of 6,000 feet from the main control panel. The RPS-1000 shall contain an additional RS-485 bus that is completely compatible with all IFP-2100ECS add on modules; including 5815XL SLC expanders, RA-2000-SK5865-SK5880 annunciators, 5824 serial/parallel module and addressable devices. The RPS-1000 will also act as a bus repeater so that additional RS-485 (modules) devices can be connected at a maximum distance of 6,000 feet from the power module.

2. The 5496 power module must have 6 amps of output power and four circuits rated at 3 amps each. The four circuits can be programmed as notification outputs or auxiliary power outputs of door holder, constant and resettable types.

P. Digital Communicator
   1. The digital communicator must be an integral part of the control panel and be capable of reporting all zones or points of alarm, supervisory, and trouble as well as all system status information such as loss of AC, low battery, ground fault, loss of supervision to any remote devices with individual and distinct messages to a central station or remote station. The communicator must also be capable of up/downloading of all system programming options, event history and detector sensitivity compliance information to a PC on site or at a remote location.
   2. The communicator shall have an answering machine bypass feature that will allow the panel to respond to communication even on phone lines that have other communication equipment present. The communicator must be capable of reporting via SIA and Contact ID formats. The communicator shall have a delayed AC loss report function which will provide a programmable report delay plus a 10-25 min random component to help ease traffic to the central station during a power outage. No controls that use external modems for remote programming and diagnostics shall be accepted.

Q. Dual Path Communicator

   1. An IP Internet and GSM Dual-Path Communicator with IP Primary/Cellular backup paths. Honeywell IPGSM-4GC communicator with BAT-1270 battery, 12V, 7AH.

R. Dry Contacts
   1. The FACP will have three form “C” dry contacts, one will be dedicated to trouble conditions, the other two will be programmable for alarm, trouble, sprinkler supervisory, notification, pre-alarm, waterflow, manual pull, aux. 1 or aux. 2. The trouble contact shall be normal in an electrically energized state so that any total power loss (AC and battery) will cause a trouble condition. In the event that the microprocessor on the FACP fails the trouble contacts shall also indicate a trouble condition.

S. Ground Fault Detection
   1. A ground fault detection circuit shall be used to detect positive and negative grounds on all field wiring. The ground fault detector shall operate the general trouble devices as specified but shall not cause an alarm to be sounded. Ground faults will not interfere with normal operation, such as alarm, or other trouble conditions.

T. Overcurrent Protection
   1. All low voltage circuits will be protected by microprocessor controlled power limiting or have a self-restoring poly-switches for the following: smoke detector power, main power supply, indicating appliance circuits, battery standby power and auxiliary output.

U. Test Functions
   1. A “Lamp Test” mode shall be a standard feature of the fire alarm control panel and shall test all LED’s and the LCD display on the main panel and remote annunciators.
   2. A “Walk Test” mode shall be a standard feature of the fire alarm control panel. The walk test feature shall function so that each alarm input tested will operate the associated notification appliance for 6 to 180 seconds. The FACP will then automatically perform a reset and confirm normal device operation. The event memory shall contain the information on the point tested, the zone tripped, the zone restore and the individual points return to normal.

3. A “Fire Drill” mode shall allow the manual testing of the fire alarm system notification circuits. The fire drill shall be capable of being controlled at the main annunciator, remote annunciators and via a remote contact input.
4. A “Bypass Mode” shall allow for any point or NAC circuit to be bypassed without effecting the operation of the total fire system.

V. Remote Input Capabilities
1. The control panel shall have provisions for supervised switch inputs for the purpose of alarm reset and alarm and trouble silence.

W. Notification Appliance Mapping
1. All notification circuits and modules shall be programmable via a mapping structure that allows for a maximum of 999 output groups.
2. Each of these groups shall have the ability to be triggered by any of the panels 999 zones, panel wide events, or site wide events. Additionally, each zone, panel, or site will individually control the cadence pattern of each of the groups that it is mapped to so that devices can indicate a variety of conditions. The zone, panel, or site shall be capable of issuing a different cadence pattern for each of the groups under its control. The mapping structure must also allow a group to be designated to “ignore cadence” for use with strobes and other continuous input devices.
3. Zones shall have ten different output categories; Detector Alarm, Trouble, Supervisory, Pre-alarm, Waterflow, Manual Pull, Zone Auxiliary 1 and Zone Auxiliary 2, CO Alarm and CO Supervisory.
4. Each of the categories shall have the ability to control output groups with a cadence pattern. The patterns are; March code, ANSI 3.41, Single Stroke Bell Temporal, California Code, Zone 1 Coded, Zone 2 Coded, Zone 3 Coded, Zone 4 Coded, Zone 5 Coded, Zone 6 Coded, Zone 7 Coded, Zone 8 Coded, Custom Output Pattern 1, Custom Output Pattern 2, Custom Output Pattern 3, Custom Output Pattern 4, Constant, System Sensor Synchronization, Wheelock Synchronization, Gentex Synchronization, Amseco Synchronization, and Faraday Synchronization.
5. This mapping/cadence pattern shall be supported by all system power supplies.
6. 15 recordable one-minute messages are available that can be mapped to eight ECS buttons.
7. ECS messages can have priority over fire alarm outputs.

X. On Board Programmer
1. The FACP shall have an on-board programmer which will allow for all system functions and options, except for mapping, to be programmed via the on board annunciator keypad. Any panel that does not have this capability will not be accepted.

Y. Downloading Software
1. The fire alarm control panel must support up/downloading of system programming from a PC. The FACP must also be able to download the detector sensitivity test results and a 1,000-event system event buffer to the PC. Communication shall take place over a direct connection to the PC and/or via the same telephone lines as the built in digital communicator and shall not require an external modem to be connected to the panel. The downloading software shall contain a code that will block unauthorized persons from accessing the panel via direct connection or over the phone lines.

Z. English Language Descriptions
1. The FACP shall provide the ability to have a text description of each system device, input zone and output group on the system. The use of individual lights to provide descriptions will not be acceptable.

2.4 SYSTEM OPERATION

A. Alarm
1. When a device indicates any alarm condition the control panel must respond within 10 seconds. All programmed audio and visual devices will activate at this time. The Alarm or Supervisory LED on the annunciator(s) should light and the LCD should prompt the user as to

the number of current events. The alarm information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators.

2. When the alarmed device is restored to normal, the control panel shall be required to be manually reset to clear the alarm condition, except that the alarms may be silenced as programmed.
3. An alarm shall be silenced at the main or remote annunciators. When silenced, this shall not prevent the resounding of subsequent events if another event should occur (subsequent alarm feature). When alarms are silenced the silenced LED on the control panel, and on any remote annunciators shall remain lit, until the alarmed device is returned to normal.

B. Troubles
1. When a device indicates a trouble condition, the control panel System Trouble LED should light and the LCD should prompt the user as to the number of current events. The trouble information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators.
2. When the device in trouble is restored to normal, the control panel shall be automatically reset. The trouble restore information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators. A trouble shall be silenced at the main or remote annunciators. When silenced, this shall not prevent the resounding of subsequent events if another event should occur.

C. Supervision Methods
1. Each SLC loop shall be electrically supervised for opens and ground faults in the circuit wiring and shall be so arranged that a fault condition on any loop will not cause an alarm to sound. Additionally, every addressable device connected to the SLC will be supervised and individually identified if in a fault condition. The occurrence of any fault will light a Trouble LED and sound the system trouble sounder but will not interfere with the proper operation of any circuit which does not have a fault condition.
2. Each indicating appliance circuit shall be electrically supervised for opens, grounds and short circuit faults, on the circuit wiring, and shall be so arranged that a fault condition on any indicating appliance circuit or group of circuits will not cause an alarm to sound. The occurrence of any fault will light the trouble LED and sound the system trouble sounder but will not interfere with the proper operation of any circuit which does not have a fault condition.

2.5 SYSTEM COMPONENTS

A. Control Unit
1. Cabinet:
   a. The system cabinets shall be red and can be either surface or flush mounted.
2. Audible System Trouble Sounder:
   a. An audible system trouble sounder shall be an integral part of the control unit. Provisions shall also be provided for an optional supervised remote trouble signal.
3. Power Supply and Charger:
   a. The entire system shall operate on 24 VDC, filtered switch mode power supply with the rated current available of 9 Amps. The FACP must have a battery charging circuit capable of complying with the following requirements:
   b. Sixty (60) hours of battery standby with five (5) minutes of alarm signaling at the end of this sixty (60) hour period (as required per NFPA 72 remote station signaling requirements) using rechargeable batteries with automatic charger to maintain standby gel-cell batteries in a fully charged condition.

      OR

      Twenty-four (24) hours of battery standby with five (5) minutes of alarm signaling at the end of this twenty-four (24) hour period (as required per NFPA 72 central station signaling requirements) using rechargeable batteries with automatic charger to maintain gel-cell batteries in a fully charged condition.
   c. The power supply shall comply with U.L. Standard 864 for power limiting.

d. The FACP will indicate a trouble condition if there is a loss of AC power or if the batteries are missing or of insufficient capacity to support proper system operation in the event of AC failure. A “Battery Test” will be performed automatically every minute to check the integrity of the batteries. The test must disconnect the batteries from the charging circuit and place a load on the battery to verify the battery condition.
e. In the event that it is necessary to provide additional power one or more of the Model RPS-1000 or 5496 distributed power modules shall be used to accomplish this purpose.

4. Connections and Circuits:
   a. Connections to the light and power service shall be on a dedicated branch circuit in accordance with the National Fire Alarm Code NFPA 72, National Electrical Code (NEC) NFPA 70, and the local authority having jurisdiction (AHJ). The circuit and connections shall be mechanically protected.
   b. A circuit disconnecting means shall be accessible only to authorized personnel and shall be clearly marked “FIRE ALARM CIRCUIT CONTROL”.

2.6 SYSTEM ACCESSORY COMPONENTS

A. FACP

1. The FACP shall support the following devices on the RS-485 data bus:
   a. ECS-VCM Voice Control Module
   b. ECS-SW24 Additional 24 Zone Switch Module
   c. ECS-50W 50 Watt Amplifier
   d. ECS-125W 125 Watt Amplifier
   e. ECS-DUAL50W 50/100 Watt Dual Channel Amplifier with 50 Watt Backup
   f. ECS-CE4 4 Zone Splitter
   g. ECS-RCU Remote Microphone (7 max.)
   h. 5815XL Signaling Line Circuit Expander (SLC) Module
   i. 5824 Printer Interface Module
   j. RA-2000 LCD Remote Annunciator
   k. 5865-3 LED Remote Annunciator
   l. 5865-4 LED Remote Annunciator with reset and silence switches
   m. 5880 LED I/O module
   n. RPS-1000 Intelligent Distributed Power Module
   o. 5496 Intelligent Distributed Power Module
2. The FACP shall support the operation of 159 detectors and 159 addressable modules per SLC loop without regard to device type. The following devices shall be supported:
   a. IDP-Photo Addressable Photoelectric Smoke detector
   b. IDP-Photo-T Addressable Photoelectric Smoke detector with Thermal
   c. IDP-PhotoR Addressable Photoelectric Smoke detector with Relay
   d. IDP-Ion Addressable Ionization Sensor
   e. IDP-Heat Addressable Heat Sensor
   f. IDP-Heat-ROR Addressable Heat with Rate of Rise
   g. IDP-Heat-HT Addressable Heat High temp 190°
   h. IDP-Acclimate Addressable Multi Criteria Smoke detector with thermal
   i. IDP-6AB 6” detector base
   j. DNR Addressable Duct Detector Housing
   k. IDP-Relay Addressable Relay Module
   l. IDP-Relay-6 Addressable Multi Relay Module
   m. IDP-RelayMon-2 Addressable Relay/Input Module
   n. IDP-Monitor Addressable Input Module (Class A or B)
   o. IDP-Minimon Mini Input Module
   p. IDP-Monitor-2 Addressable Dual Input Module
   q. IDP-Monitor-10 Addressable Multi Input Module (10)
   r. IDP-Control Addressable Notification Module
   s. IDP-Control-6 Addressable Notification Multi Module (6)
   t. IDP-Zone Two Wire Smoke Detector Module

u. IDP-Zone-6 6 Multi Smoke Detector Module
v. IDP-Iso Isolation Module
w. IDP-Beam Addressable Beam Detector
x. IDP-Beam-T Addressable Beam Detector with Test feature
y. B224BI Addressable Isolator base
z. B224RB Detector Relay Base
aa. B200SR Detector Sounder Base
bb. B200S Intelligent Detector Sounder Base
cc. RTS151KEY Remote Test Switch for Photoelectric Duct Detector
dd. RTS151 Remote Test Switch for Photoelectric Duct Detector
ee. IDP-Pull-SA Addressable Single Action Pull Station
ff. IDP-Pull-DA Addressable Dual Action Pull Station

3. The FACP shall support these other Silent Knight devices via addressable input, addressable notification, or addressable output modules.
   a. PS-DALOB Dual Action Manual Pull Outdoor Listed
   b. PS-DAH Dual Action Manual Pull Hex Key reset
   c. PS-SATK Single Action Manual Pull Station – Key Reset
   d. PS-DATK Dual action Manual Pull Station – Key Reset
   e. PS-DASP Dual action Manual Pull Station “Spanish”- Key reset
   f. SB-I/O Surface mount back box for outdoor use.

B. Furnish and install, where shown on the drawings, the following devices:

C. Manual Fire Alarm Stations
1. Manual fire alarm stations shall be non-coded, break glass, single or double action type, with a key operated test-reset lock in order that they may be tested, and so designed that after actual emergency operation, they cannot be restored to normal except by use of a key. The reset key shall be so designed that it will reset manual station and open FACP without use of another key. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of fifty feet, front or side. Manual stations shall be constructed of die cast metal or polycarbonate with clearly visible operating instructions on the front of the stations in raised letters. Stations shall be suitable for surface mounting on matching backbox, or semi-flush mounting on a standard single-gang box and shall be installed within the limits defined by the Americans with Disabilities Act (ADA) dependent on manual station accessibility or per local requirements. Manual stations shall be installed in conjunction with an addressable input module, IDP-Monitor or IDP-Minimon. Manual stations shall be Silent Knight Underwriters Laboratories listed. SK #PS-DATK Dual action Manual Pull Station – Key Reset.
2. Manual station protective covers: STI #STI-6605 Mini Stopper II® with Horn.

D. Remote Power Supplies
1. The remote power supplies for notification appliances shall be the Silent Knight Model RPS-1000 or 5496. The Model RPS-1000 intelligent power supply shall wire on the main SBUS and be programmed through the IFP-2100ECS. It will support 6 amps of 24-volt DC power with 6 Flexput™ circuits, rated at 3 amps each. Two additional 5815XL SLC loop expanders shall be capable of be install in the cabinet. The power supply will also regenerate the SBUS for an additional 6000 feet of SBUS capability.
2. The Silent Knight 5496 intelligent power supply shall wire on the main SBUS and be programmed
3. through the IFP-2100ECS. It will support 6 amps of 24-volt DC power with 4 notification circuits, rated at 3 amps each.
4. The remote power supply model 5499 or 5495 may also be used on the system. These power supplies are activated by a notification circuit or an IDP-Control module and support 6amps of 24VDC power, with 4 notification circuits, rated at 3amps each.

E. Local Operator Console
1. Combination supervised remote microphone and annunciator compatible with the IFP-2100ECS control panel.

2. Console shall include an RCS-RVM remote voice module and its associated RA-2000 keypad annunciator.

F. Notification Devices
1. The visible and audible/visible signal shall be System Sensor series signal devices and be listed by Underwriters Laboratories Inc. per UL 1971 and/or 1638 and UL 464. The notification appliance (combination audible/visible units only) shall produce a peak sound output of 90dba or greater as measured in an anechoic chamber. The signaling appliance shall also have the capability to silence the audible signal while leaving the visible signal energized with the use of a single par of wires. Additionally, the user shall be able to select either continuous or temporal tone output with the temporal signal having the ability to be synchronized.
2. The visible signaling appliance shall maintain a minimum flash rate of 1Hz or greater regardless or power input voltage. The appliance shall also be capable of meeting the candela requirements of the blueprints presented by the engineer and ADA. The appliance shall be polarized to allow for electrical supervision of the system wiring. The unit shall be provided with terminals with barriers for input/output wiring and be able to mount to a single gang or double gang box or double workbox with the use of an adapter plate. The unit shall have an input voltage range of 20-30 volts with either direct current or full wave rectified power.

G. Speakers:
1. Operate on 24 VRMS or with field-selectable output taps from 0.5 to 2.0 watts.
2. Speakers for Acoustically Distinguishable Space (ADS): Produce maximum nominal sound output of 86 dBA at 10 feet (3 m). Provide speaker type and quantities in each space to provide required sound levels and intelligibility for the space.
3. Frequency Response: Minimum of 400 Hz to 4,000 Hz.
4. Back of Each Speaker: Sealed to protect speaker cone from damage and dust.

H. Strobes:
1. Compliance: ADA and UL 1971.
2. Maximum Pulse Duration: 0.2 second.
3. Strobe Intensity: UL 1971.
4. Flash Rate: UL 1971.
5. Strobe Candela Rating: Determine Candela output by positioning selector switch on back of device. Candela outputs available shall include 15, 15/75, 30, 75, 110, 135, 150, 177, and 185.

I. Speaker/Strobes:
1. Operate on 24 VRMS or with field-selectable output taps from 0.5 to 2.0 watt
2. Speaker/Strobes for Acoustically Distinguishable Spaces (ADS): Produce maximum nominal sound output of 86 dBA at 10 feet (3 m). Provide speaker type and quantities in each space to provide required sound levels and intelligibility for the space.
3. Frequency Response: Minimum of 400 Hz to 4,000 Hz.
4. Back of Each Speaker: Sealed to protect speaker cone from damage and dust.
5. Audibility: NFPA 72.
6. Maximum Pulse Duration: 0.2 second.
7. Strobe Intensity: UL 1971.
8. Flash Rate: UL 1971.
9. Strobe Candela Rating: Determine Candela output by positioning selector switch on back of device. Candela outputs available shall include 15, 15/75, 30, 75, 110, 135, 150, 177, and 185.

J. Smoke Detectors
1. Smoke detectors shall be Silent Knight Model IDP-Photo ceiling mounted, analog/addressable photoelectric smoke detectors. The combination detector head and twist lock base shall be U.L. listed compatible with the Silent Knight IFP-2100ECS fire alarm control panel. The base shall permit direct interchange with Silent Knight's IDP-Ion, IDP-Acclimate, or the IDP-Heat detectors. The base shall be the appropriate twist lock base B210LP. The smoke detector shall have a flashing status LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady at full brilliance. The detector may be reset by actuating the control panel's reset switch. The sensitivity of the detector shall be capable of being selected and measured by the control panel without the need for external test equipment. The vandal

security-locking feature shall be used in those areas as indicated on the drawing. The locking feature shall be field selectable when required. It shall be possible to perform a sensitivity test of the detector without the need of generating smoke. The test method shall simulate the effects of products of combustion in the chamber to ensure testing of the detector circuits. Detectors shall have completely closed back to restrict entry of dust and air turbulence and have a 30-mesh insect screen. Electronics of the unit shall be shielded to protect against false alarms from E.M.I. and R.F.I.

K. Heat Detectors
   1. Furnish and install analog/addressable heat detectors, Silent Knight model IDP-Heat. The combination heat detector and twist lock base shall be U.L. listed compatible with the Silent Knight IFP-2100ECS fire alarm control panel. The base shall permit direct interchange with the Silent Knight IDP-Ion, IDP-Photo, or IDP-Acclimate detectors. The base shall be appropriate twist lock base B210LP. The heat detector shall have a flashing status LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady at full brilliance. The detector may be reset by actuating the control panel's reset switch. The vandal security-locking feature shall be used in those areas as indicated on the drawings. Electronics of the unit shall be shielded to protect against false alarms from E.M.I. and R.F.I.

L. Duct Detectors
   1. Duct Detector shall be Silent Knight Model DNR Duct Detector Housing. A separate IDP-Photo or IDP-PhotoR is required. The duct detector housing shall be capable of housing the IDP-Relay module for optional output devices.

M. Annunciator Graphic Plaque:
   1. Provide adjacent to the main remote annunciator, a color-coded graphic floor plan sheet, in a powder coated black colored metal frame with polycarbonate overlay. Plaque shall indicate significant areas or "zones" of the building, fire protection riser room, FACP location, LOC location, annunciator locations and main egress doors to building, to aid the responders and to help in identifying the area of the building producing the alarm. The custom labeling of each initiating device shall be programmed into the Fire Alarm system to begin with the area or "zone" number that matches this graphic plaque. Plaques shall be able to be easily changed without removing the frame from the wall and all mounting hardware shall be concealed. Plaque shall be a minimum of 24 inches by 24 inches. Plaque shall indicate the FACP location.
   2. Graphic plan of building indicating alarm zones that match the FA descriptions displayed on the annunciators, location of electrical service and other information required by the AHJ.

2.7 ROUGH-IN AND WIRING MATERIALS

A. Conduit
   1. All Fire Alarm system wiring conduit shall be factory applied red EMT.

B. Boxes
   1. All Fire Alarm system junction boxes shall be painted red.
   2. Surface fire alarm device boxes shall be factory applied red.

C. System Cable
   1. All cable shall be UL listed for Fire Alarm systems.
   2. Cable shall have a red outer jacket.
   3. Open air cable shall be plenum rated.

2.8 EXTRA MATERIALS

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

B. Extra materials may not be allowed for publicly funded projects.

C. Furnish and install the extra materials described in subparagraphs below that match products provided. These devices shall be installed as directed during construction. The contractor shall

consider a difficult installation that may require ceiling tiles to be removed/replaced, cut-in boxes used and walls to be “fished” to install the devices where directed in their unit pricing for these devices. The cost of providing the rough-in material and labor for these fire alarm devices shall be included under this specification section (28 3100).

D. Extra materials that are not installed during construction shall be turned over to the owner at the end of construction (closeout) and credit rendered for labor. Products that are not installed shall be packaged in their original containers with protective covering for storage and identified with labels describing contents.

E. The contractor shall include the following in their bid:
   1. Ten 30cd speaker/strobe light appliances per these specifications.
   2. Ten speaker only appliances per these specifications.
   3. Ten smoke detectors per these specifications.
   4. Five rate of rise heat detectors per these specifications.
   5. 35 rough-ins including (1) 4” square, deep box with single gang ring and 15’’ of 3/4" EMT conduit with (2) sweeps. Note: cut-in boxes and flex will be used if extra devices are to be located after wall finish.
   6. 50’ of Fire Alarm cable, plenum rated as required for ceiling space, per device.
   7. Labor for installing all extra materials.
   8. Submit a fair cost value unit price for these devices that separates material and labor with the pre-construction device submittals. At the Architect or Engineer’s option this fair cost value may be applied to other work not included in the bid documents. This fair cost unit pricing shall be used as a basis to verify change order cost proposals for similar work.
   9. Unused labor shall be credited back to the owner after AHJ approval and issuance of certificate of occupancy at the end of the project construction.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The system vendor shall calculate the audible characteristics for each Acoustically Distinguishable Space (ADS) and provide the appropriate alarm devices to achieve audio intelligibility. Multi-Purpose Rooms, Corridors, etc. shall be separate ADS and may require more speakers for intelligibility coverage than what is indicated on the construction documents. Provide visual and speaker appliance types and quantities in each space to provide required sound levels and intelligibility for the space.

B. The installer shall coordinate the installation of the fire alarm equipment. All conductors and wiring shall be installed according to the manufacturer’s recommendations.

C. It shall be the installer’s responsibility to coordinate with the supplier, regarding the correct wiring procedures before installing any conduits or conductors.

D. System components shall be installed in accordance with the latest revisions of the appropriate NFPA pamphlets, the requirements contained herein, National Electrical Code, local and state regulations, the requirements of the fire department and other applicable authorities having jurisdiction (AHJ).

E. Fire Alarm cable may be run “open air” above accessible ceiling spaces and supported from J-hooks and/or D-rings, at a maximum of 5’-0” O.C. The contractor shall verify with the HVAC system installer where spaces are used as air plenum. Provide plenum rated cable where required for open air installations or install riser cable in conduit. Provide conduit raceways from above ceiling to wall mounted devices. Conduit shall be concealed in walls and boxes mounted flush. Where exposed conduit is used in open-to-structure spaces, route conduit to be parallel and perpendicular to the adjacent structure. Make every effort to conceal conduit from view where possible. Conduit shall be installed prior to painting.

F. Where devices are located in hard lid ceilings or walls, conceal conduit, mount junction boxes so that plates are flush with the finished surface and conduit supported from structural members.

G. Where devices are installed in open ceiling spaces, mechanical mezzanines, etc., install conduit parallel and perpendicular to the structure. In open ceiling spaces install conduits prior to painting. Conceal or expose conduit, junction boxes, and conduit supports and hangers in unfinished areas.

H. All wire used on the fire alarm system shall be U.L. Listed as fire alarm protection signaling circuit cable per National Electrical Code, Articles 760.

I. Do not install smoke detectors before system programming and test period. If construction is ongoing during this period, take measures to protect smoke detectors from contamination and physical damage.

J. Flush-mount fire detection and alarm system devices, control panels, and remote annunciators in finished areas. Flush-mount or surface-mount fire detection and alarm system devices, control panels, and remote annunciators in unfinished areas.

K. Ensure manual stations are suitable for surface mounting or semi-flush mounting as indicated on the Drawings. Install not less than 42 inches, or more than 48 inches, above finished floor measured to operating handle.

L. Install the Graphic plan of building indicating FACP, LOC and alarm zones that match the FA descriptions, at the annunciator located at the main fire department response entry.

M. Coordinate the location of the control relay for HVAC shutdown to be with-in 36” of the starter or VFD, with the mechanical controls contractor.

N. Install the LOC adjacent to the FACP in a secure room as indicated on the drawings. Provide signage on the door indicating that the FA control panel is located within. A smoke detector is required to be provided at the FACP.

3.2 FIELD QUALITY CONTROL

A. Manufacturer’s Field Services:
   1. Provide service of competent, factory-trained technician authorized by manufacturer to technically supervise and participate during pre-testing and acceptance testing of system.

B. Testing:
   1. Conduct complete visual inspection of control panel connections and test wiring for short circuits, ground faults, continuity, and insulation before energizing cables and wires.
   2. Close each sprinkler system control valve and verify proper supervisory alarm at INCC Command Center.
   3. Verify activation of flow switches.
   4. Open initiating device circuits and verify that trouble signal actuates.
   5. Open signaling line circuits and verify that trouble signal actuates.
   6. Open and short notification appliance circuits and verify that trouble signal actuates.
   7. Ground initiating device circuits and verify response of trouble signals.
   8. Ground signaling line circuits and verify response of trouble signals.
   9. Ground notification appliance circuits and verify response of trouble signals.
   10. Check alert tone and prerecorded voice message in English and Spanish to alarm notification devices.
   11. Check installation, supervision, and operation of intelligent smoke detectors.
   12. Introduce on system each of the alarm conditions that system is required to detect. Verify proper receipt and proper processing of signal at INCC Command Center and correct activation of control points.
   13. Consult manufacturer’s manual to determine proper testing procedures when system is equipped with optional features. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality, and similar.

C. Acceptance Testing:
   1. Before installation shall be considered completed and acceptable by AHJ, a complete test using as a minimum, the following scenarios shall be performed and witnessed by

representative approved by Engineer. Monitoring company and/or fire department shall be notified before final test in accordance with local requirements.

2. Contractor's job foreman, in presence of representative of manufacturer, representative of Owner, and fire department shall operate every installed device to verify proper operation and correct annunciation at control panel.
3. Open signaling line circuits and notification appliance circuits in at least 2 locations to verify presence of supervision.
4. Completely disconnect INCC Command Center from rest of network, including Voice INCC Command Center. Activate initiating device from transponder. All speaker circuits activated from each transponder shall transmit the correct evacuation or alert message. These messages shall be same messages transmitted with INCC Command Center activated. Default tones or messages shall not be acceptable.
5. Completely disconnect INCC Command Center from rest of network. Activate initiating device. All control outputs supported by transponder SLC circuits shall operate under project programming mode. Default or degrade mode programming shall not be acceptable.
6. All audio risers shall be directly shorted between INCC Command Center and first audio transponder, followed by activation of alarm initiating device. Correct pre-recorded messages shall transmit from all speakers, including evacuation and alert channels. Default or degrade messages shall not be acceptable.
7. The communication loops and the indicating appliance circuits shall be opened in at least two (2) locations per circuit to check for the presence of correct supervision circuitry.
8. When testing has been completed to satisfaction of both Contractor's job foreman and representatives of manufacturer and Owner, a notarized letter co-signed by each attesting to satisfactory completion of said testing shall be forwarded to Owner and fire department.
9. Leave fire alarm system in proper working order and, without additional expense to Owner, replace defective materials and equipment provided within one year (365 days) from date of final acceptance by the owner.

D. Record Drawings:
   1. A complete set of reproducible "as-built" drawings showing installed wiring, color coding, and wire tag notations for exact locations of all installed equipment, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of system.
   2. Record shop drawings shall also be provided in electronic PDF format.

3.3 DEMONSTRATION

A. Provide instruction to the owner's appointed staff as required for operating fire alarm system.

B. Provide hands-on demonstrations of operation of fire alarm system components and functions.

END OF SECTION 28 31 00

SECTION 28 3113 - ACCESS CONTROL AND INTRUSION ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 01 and 08 specifications, apply to work specified in this section.

B. Refer to Division 28, Section 28 05 00, "Common Work Results for Electronic Safety and Security," for general requirements that apply to this section. Comply with all requirements of Section 28 05 00.

C. Refer to Division 27, Section 27 15 00, "Communications Cabling." Comply with all requirements of this section.

D. Related work:
   1. Closeout Procedures: Manufacturer's Warranties
   2. Door Hardware
   3. Basic Materials and Methods
   4. Raceway Systems
   5. Wire and Cable
   6. Outlet Boxes
   7. IP Video Surveillance
   8. The provisions of the Agreement, including bonds and certificates, the General Conditions, and Division 01 specification sections apply to all work of the Section. Substitutions: Substitute products will not be considered under the terms and conditions of this section.

E. Related sections:
   1. Section 28 00 10: General Provisions
   2. Section 28 05 00 Common Work for Electronic Security & Safety
   3. Section 26 05 33: Raceway & Boxes
   4. Section 26 05 29: Hangers & Supports
   5. Section 26 05 33: Identification
   6. Section 28 23 00: Video Surveillance System

1.2 SUMMARY

A. Provide in operating condition an electrically operated access control and intrusion detection system as described herein. The system shall include, but not be limited to, control panel, power supplies, proximity card readers, cards, keypads, detection devices, programming, conduit, wire, fittings and other relevant components and accessories required to provide a complete operating security system. All units shall be located in accordance with the plans.

B. The access control and intrusion detection system shall utilize applications based upon the Digital Monitoring Products (DMP) platform.

C. Provide a complete intrusion detection system with a digital communicator for digital transmission to a Remote Reporting Agency.

D. Program the intrusion detection-Access Control systems in accordance with directions received from the Owner's Representative.

E. Adjust and test the intrusion detection-Access systems and demonstrate the system to the Owner's Representative.

F. Instruct the Owner's staff in operating the systems and recommended maintenance procedures.

1.3 QUALITY ASSURANCE

A. The system and its components shall be Underwriters Laboratories, Inc., listed under the appropriate UL testing standard as listed herein for security access control applications and shall be in compliance with the UL listing. The system supplier/installer shall be an authorized distributor of the system manufacturer

B. Underwriters Laboratories (UL):
   1. UL 609 – Local Burglar Alarm Units and Systems
   2. UL 1635 – Digital Burglar Alarm Communicator System Units

C. Federal Communications Commission (FCC):
   1. Code of Federal Regulations Title 47 - Part 15 – Radio Frequency Devices.
   2. Code of Federal Regulations Title 47 - Part 68 – Connection of Terminal Equipment to the Telephone Network.

D. National Fire Protection Association (NFPA):
   1. NFPA70 – National Electrical Code – section 725.

1.4 STANDARDS

A. The system shall be listed as a Power Limited Device and be listed under the standards below. Each system shall be supplied with complete details on all installation criteria necessary to meet all of the listings.

BURGLARY LISTINGS	U.S. GOVERNMENT STANDARDS/LISTINGS
UL 1023 HOUSEHOLD BURGLAR ALARM SYSTEM UNITS	MEETS ICD 705 CHAPTER 7 INTRUSION DETECTION SYSTEMS (IDS)
UL 1076 PROPRIETARY BURGLAR	MEETS DOD/NIST SCIF STANDARDS
UL 1610 CENTRAL STATION BURGLAR ALARM UNITS	RELATED STANDARDS
UL 1635 DIGITAL BURGLAR ALARM COMMUNICATOR SYSTEM UNITS	NFPA 70 NATIONAL ELECTRIC CODE (NEC)
FIRE LISTINGS	NFPA 72 LOCAL PROTECTIVE SIGNALING
UL 864 CONTROL UNITS FOR FIRE PROTECTIVE SIGNALING SYSTEMS	NFPA 72 REMOTE STATION PROTECTIVE SIGNALING
UL 985 HOUSEHOLD FIRE WARNING	NFPA 72 PROPRIETARY PROTECTIVE SIGNALING
CALIFORNIA STATE FIRE MARSHAL	NFPA 72 HOUSEHOLD FIRE WARNING
NEW YORK CITY FDNY COA #6167	CANADIAN BURGLARY LISTINGS
ACCESS CONTROL LISTINGS	ULC C1023 HOUSEHOLD BURGLAR
UL 294 ACCESS CONTROL SYSTEM UNITS	ULC/ORD-C1076 PROPRIETARY BURGLAR
NIST	ULC S304 CENTRAL STATION BURGLAR
AES ALGORITHM CERTIFICATE #2350 128	CANADIAN FIRE LISTINGS
AES ALGORITHM CERTIFICATE #2595 256	ULC S545 HOUSEHOLD FIRE
	ULC S559 FIRE SIGNAL RECEIVING CENTRES AND SYSTEMS

B. Americans with Disabilities
   1. All indicating, and notification appliances shall comply with the Americans with Disabilities Act (ADA) requirements.

1.5 SYSTEMS DESCRIPTION

A. The security intrusion alarm system shall consist of an integrated alarm processor, digital communicator, keypads, and shall support the connection, monitoring and reporting of intrusion devices.

B. The system shall include an automatic dialer to report alarms over dial-up telephone lines to the Owner's monitoring vender, Moon Security. Provide dialer programming hardware, software and services. Program dialer as requested by the Owner and their monitoring company.

C. System shall be capable of monitoring no less than 574 custom points for security devices.

D. Interior space protection will be achieved by use of PIR/microwave motion devices and door openings shall be determined by magnetic door switches. Door switches and motion detectors shall be configured for a two-zone layout. The kitchen shall be on a separate zone for the rest of the entire building.

E. The system shall be able to communicate and be programmed for alarm conditions at both the individual point and zone level.

F. The Access Control System (ACS) shall provide active door entry management by credential readers at selected entry points and Owner issuance of credentials to users to allow authorized entry as to be determined by the Owner. The Access Control system monitors and controls facility access, and performs alarm monitoring, selected camera and video monitoring, communications loss monitoring, and temperature monitoring. The system also maintains a database of system activity, personnel access control information, and system user passwords and user role permissions. The system is controlled from a web browser and requires software installation and client licenses. Requires all Entre Access Control Licenses to be purchased and managed by Certified Entre installation company for Owner. The system provides control and access to users on Local Area Networks (LAN), Wide Area Networks (WAN), wireless networks, and the Internet. The system provides email and/or text message alerts for all alarm conditions and threats.

G. The Access Control System shall provide the following card access control operational objectives
   1. Controlled entry, via access card readers of only authorized personnel to secured areas based on cardholder information entered and entered and stored in the system database.
   2. The access request response time from card presentation, data base verification, to electric look unlock shall be no more than one second in normal operating mode on a fully loaded system.
   3. All access request, both authorized and denied, shall be sent to the host for storage and annunciation, as required, with the cardholder number, name, and access point/area where access was attempted or gained.
   4. Each card can be disabled at any time.
   5. Each cardholder shall be specified with access authority to a combination of Security Areas.
   6. The system shall provide for the designation of certain calendar days to be holidays, with special access privileges and system activity to be specified for those days.

H. The system shall provide the following relay output control and operational functions:
   1. Each security system output point (door lock, gate controller and other associated relay outputs) shall have a user-specified 16 character, minimum, test identifier. Each point shall be software programmable for activation and deactivation, and shall be capable of reporting short circuit trouble, open circuit trouble, ground fault trouble and circuit fault trouble.

I. The system shall allow activation and deactivation of output points manually by the operator, automatically by time zone, automatically by the activation of an alarm point, or, where required by a card reader.

J. Entre Floor Plan with access control, security devices and camera locations. Entre will be able to control and monitor areas thru Entre Floor Plan tie in. Will be able to view security zones in ready, not ready, alarm, be able to view and control access doors, be able to view camera, security keypad

locations, access/security panel locations, fire panel location, riser room locations, temperature sensor locations shall be added to Floor Plan to view status. The fire alarm system will include addressable relays to trigger the locations mentioned above for alarm, supervisory and trouble alarms. Floor Plan shall be installed in the PSD Entre System by a Certified Entre installation company for them to control and manage.

K. System shall interface with the building lockdown system and networked lighting control system.

1.6 MANUFACTURER

A. The manufacturer shall have at least fifteen (15) years of experience in the role of access and security control manufacturing, and a proven track record of forward and backward compatibility for a minimum of fifteen (15) years for its product's auxiliary devices, including system keypads, annunciation devices, zone expansion modules, and addressable detection devices.

B. The manufacturer must also manufacture receiving equipment that is compatible with standard dial-up telephone lines, network, and cellular network monitoring equipment that is compatible with a LAN, WAN, and the Internet. The receiving equipment shall be capable of receiving all status and alarm messages generated by the system. The receiving equipment shall be capable of updating the panel operating program and the system date and time.
   1. Commercial Intrusion detection/Access control equipment manufacturer shall be:
      a. Digital Monitoring Products, Incorporated (DMP)
      b. Partnership Boulevard, Springfield, MO 65803
      c. Telephone (417) 831-9362 FAX (417) 831-1325

1.7 QUALIFICATIONS OF SYSTEM INSTALLER

A. The system vender shall be a manufacturer-authorized dealer/distributor for the intrusion detection system equipment manufacturer, for the Access Control system manufacturer and a Certified Entre Software installation company with the capability of offering factory-certified service at the project site, both during and after the warranty period.

B. The system vendor shall employ trained technicians skilled in maintenance of intrusion detection systems and Access Control systems and shall maintain a service organization within 50-mile radius of the project site. The technicians shall be licensed as required by local and State jurisdiction to preform work on limited energy systems. The service organization shall have the equivalent of 5 years' experience in servicing intrusion detection and access control systems and be capable of responding to service calls within 24 hours. Furnish references upon request. The system vendor shall be an authorized Engineered Systems Distributor (ESD) for Digital Monitoring Products (DMP). The system vendor shall also be a Security's Netbox IP based access control and Certified Entre System installation company.

C. The installing company shall furnish and install a complete electrically supervised DMP panel, as detailed in this specification. The system shall be inclusive of all necessary function, monitoring, and control capability as detailed herein and on accompanying shop drawings.

D. The installing company shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Architect of any discrepancy before performing the work. Materials shall be installed in strict compliance with local building codes. All work shall be performed in accordance with Digital Monitoring Products, Inc. instructions. Components must be installed and serviced by a dealer in good standing that is factory-trained by Digital Monitoring Products.

1.8 CENTRAL REPORTING STATION

A. The central reporting station contractor must possess an Underwriter's Laboratory (UL) listing as a "Mercantile Police Station" or "Mercantile Burglar Alarm Systems" company. A copy of the listing shall be attached as a part of this bid package.

B. The actual alarm signal receipt and processing is a significant portion of the scope of work. Third party and/or contract stations are permitted. UL must list the monitoring station for Protective Signaling Services or Central Reporting Station Signaling Services. A copy of the station UL listing shall be attached as part of this bid package.

C. The monitoring station must provide openings/closing activity reports, activity day and time, authorized individual, office name and account number and the system type being monitored. These reports are to be emailed to the user's office at the beginning of each morning from the day before. The Office Manager or Contract Administrator may request an additional report if an incident occurs.

D. The contractor must have a valid Alarm Operator License and must be a UL listed central station. A copy of licenses shall be attached as part of this bid package.

E. The Contractor will provide monitor cost for (1) year of monitoring which will be included in the bid packet.

F. The contractor shall become familiar with all work details, verify all dimensions in the field, and shall advise the Architect of any discrepancy before performing the work.

G. The end user shall not incur any central station setup charges by the contractor to receive alarm signals by way of the end user data network.

1.9 SUBMITTALS

A. General:
   1. Comply with Division 28, Section 28 05 00, "Common Work Results for Electronic Safety and Security."

B. Product Data:
   1. Submit for each type of product indicated.

C. Shop Drawings:
   1. Include complete system riser showing all ACS devices and network components.
   2. Include typical installation details for each ACS device and network component.
   3. Indicate on shop drawings the locations of each card reader and all doors with ACS equipment. Show size and route of cable and conduits.
   4. Indicate on shop drawings the locations of each magnetic contact, motion sensor, keypads and all other intrusion system devices.
   5. Indicate on shop drawings all interconnecting wiring between control equipment and peripheral devices for both systems, including wire routing, wire type and manufacturer catalog number, and wire size and conductors.

D. Submittals shall include manufacturer data sheets for all major system components.

1.10 OPERATING & MAINTENANCE MANUALS & RECORD DRAWINGS

A. Submittals: Information submitted for review, up-dated to record any changes.

B. Operating Instructions: Supply a detailed narrative description of the system operation. Indicate expansion capability, application conditions and limitations of use. Include manufacturer's installation and operating instructions.

C. Maintenance Instructions: List replacement parts, including source. Indicate recommended maintenance and testing procedures, and the intervals involved for each. List all individual system components that require periodic maintenance. Detail trouble-shooting procedures. Include a service directory with names and telephone numbers for use in obtaining service.

D. Record Drawings: The contractor shall provide a complete set of as-built drawings for the entire system upon installation completion. These drawings shall include, but not be limited to, the exact

locations of all equipment, connections between all equipment, and wiring for all equipment as the system is installed.

1. Maintain continuously updated Record Drawings (“As-Builts”) at the construction site.
2. Upon completion of installation, prepare record drawings of the system. Drawings shall be floor plans indicating exact device locations, panel terminations, cable routed, and wire numbers as tagged and color-coded on the cable tag. Final point-to-point wiring diagrams of each type of device shall be included in the record drawings.
3. Provide an electronic copy of all final record drawings on CD-ROM. Record drawing files shall be formatted in the most current version of AutoCAD (3 disks will be provided).

E. Program Record: Provide record sheets listing the panel programming selections implemented.

F. Warranty: Manufacturer’s or Vendor’s warranty certificate.

1.11 SYSTEM OPERATION

A. The system shall be programmable locally or remotely. Programming shall be accomplished via a portable programmer or a computer running the software.

B. To access the building when the security intrusion and access control system is armed and the building is locked a user will do the following:

1. Place a valid card in range of the proximity reader, which shall release the electric door latch mechanism.
2. Enter the building and disarm the security system by pressing the proper code sequence into the keypad.
3. If a card is presented to the reader during a time or date that is not within its programmed privileges, the door shall not be unlocked.
4. If a lost/stolen card is presented at the reader, access shall be denied, an alarm shall be transmitted to the local control panel, and an alarm shall further be transmitted to the monitoring station. The event shall be recorded on the local printer. The security system shall not be placed into alarm unless there is an unauthorized entry or other valid alarm condition.

C. Upon actuation of any automatic detection device, breaking of any magnetic contact, or a keypad initiated alarm, all alarm functions shall operate in appropriate fashion.

1. The following additional functions shall be performed in the event of an alarm, as shown:
2. Security alarms shall activate the remote signaling circuit of the security intrusion panel, which shall dial a coded alarm message to the remote monitoring station. If the first voice line is not usable, a second voice line shall be utilized.
3. Shutdown of the system shall be accomplished at the local control panel by authorized personnel.

D. The arming procedure shall be as follows:

1. Entering the arming code on the keypad shall cause the system to be selectively armed.
2. System shall give visual and audible indication if it is armed while a non-auto-shunted zone is in trouble status. A low battery condition shall give an audible alarm upon arming.
3. System shall dial the monitoring station number to give a closing system status report and shall give visual or audible indication of the monitoring station verification signal (ring back).
4. After system has been successfully armed and ring back has been received, the exit delay period (user programmable up to 4 minutes) shall begin (if the delay has not been canceled by the operator), allowing the operator to exit the building without causing an alarm.

E. The disarming procedure shall be as follows: Entering the disarming code on the keypad shall cause the zones to be disarmed. The other zones shall remain operational.

1. Alarm reports shall be classified into sub-categories as follows:
2. Opening and closing reports
3. Service Log
4. Test / Status Reports
5. Diagnostic

6. Relays
7. Power / Phone Supervision
8. Remote programming attempts

F. The system shall monitor the temperature of the cooler and freezer, as a high temperature alarm. Provide all required conduit, probes and wiring as required to form a complete and operational system.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Subject to compliance with these specifications, provide security access control products with HID cards, and Digital Monitoring Products (DMP) keypads, readers, controllers and interface modules. Manufacturer: Digital Monitoring Products (DMP). Substitute products will not be considered under the terms and conditions of this section.

B. Reference the Technology Component System Matrix following the Division 28 specifications for an outline of materials that are CFCI, OFCI & OFOI.

2.2 SECURITY CONTROL PANEL

A. Provide UL Listed steel enclosure, and key lock, model.

B. The control panel shall be capable of providing identification, annunciation, and communication of up to 574 identifiable points; of which 32 are on-board loops and the balance are off-board addressable points or zones.

C. Provide addressable expansion modules, model as required to provide identification for addressable devices shown on Construction Drawings.

D. Control panel shall support 12,000 event log indicating time, date, type of event, location and user ID.

E. System shall be capable of activating contacts for auxiliary functions.

F. The system shall be capable of executing diagnostics and testing functions locally or remotely.

G. Up to 10,000 different passcodes shall be supported. Passcodes may be enabled to disabled and may be assigned one of ninety-nine (99) different authority levels.

H. The control panel shall be equipped with a phone line monitor and shall interface with the phone lines via RJ-31X jacks for supervision of the telephone line connection. When a telephone line is determined to be out of service by the control panel, the event will be annunciated locally and transmitted to the monitoring station. A telephone line switching module shall be used to interface to a second telephone line. This interface shall confirm to FCC rules part 15 and 68.

I. The control panel shall provide:
1. Sixteen (16) independent door/keypad addresses, each with four zones.
2. Twenty (20) Holiday Dates for custom holiday scheduling by area.
3. A total door access granted event buffer of at least 10,000 events.
4. Anti-pass back access control selectable by area and user.
5. Four (4) shift schedules per area.
6. A total of at least 100 programmable output relay schedules.
7. Thirty-two (32) individual reporting areas.
8. Require two-man access code or credentials
9. Support programming to require the same or different access code entered within a programmed delay time of 1 to 15 minutes after disarming before activating a silent ambush alarm

10. Support area programming that disables schedule and time-of-day changes while system is armed so that area can only be disarmed during scheduled times.

J. The control panel shall be configured, but not limited to the following devices to form a complete and operational system as follows to integrate with the district software package:
   1. HID connection Devices
   2. Interface modules (counts based upon end devices)
   3. 12V and 24V power supplies
   4. Enclosure shall be 14.5”W x 32”H x 4: D and gray in color clearly marked security access panel.
   5. Access control servers shall be provided by the owner. Software upgrades and maintenance shall be coordinate directly with the owner.
      a. Manufacturer is DMP
         1) Command Processor, Part No XR550
         2) Enclosure, Part No. 352X

2.3 POWER SUPPLIES

A. Primary power:
   1. Provide a single output power supply/charger to convert 115VAC/60Hz input into one (1) class 2 ratted 12VDC power limited output.
   2. Power supply shall be UL Listed for Access Control Systems (UL294) and for use with Intrusion Detection Systems (UL603)
   3. The power supply shall have the following specifications:
      a. 5 amps @ 12VDC of continuous supply current output.
      b. Class 2 Rated power limited output.
      c. 115VAC 60Hz. 1.5 amps input
      d. Filtered and electronically regulated outputs.
      e. Short circuit and thermal overload protection.
      f. Built-in charger for sealed lead acid or gel type batter backup.
      g. Maximum charge current 7 amp.
      h. Zero voltage drop upon transfer to battery backup.
      i. AC input and DC output LED indicators.
      j. AC fall supervision
      k. Low battery supervision
   4. A dedicated 120VAC power circuit shall provide power to the intrusion detection and access control power supplies. Each circuity shall be connected to the building power system. The 120VAC input circuits to power supplies to be provided under other Sections.
   5. Primary power supervision: When the primary power source fails, the system shall report to the monitoring station.
      a. Manufacturer is DMP: Part NO 505-12LX

B. Secondary power (standby battery)
   1. Provide adequate battery power for the intrusion detection system as defined by the application criteria, UL 985 and 865 for alarm installations. Provide battery charger consistent with the battery back-up capacity. Provide standby battery power to support 24 hours of continuous operation in case of 120VAC power failure. In addition, the standby power shall support 5 minutes of alarm operation at the end of the 24-hour period.
   2. Secondary power supervision: When the secondary power source experiences an 85% depletion of its standby capacity, the system shall report a “Low Battery” message to the monitoring station. The system shall always display a low battery condition.
      a. Manufacturer is DMP, Part No 36x Series

C. All intrusion detection system and access control power supplies, other than those utilized for electronic door latch/strike power supplies shall e provided by Door Hardware contractor.

2.4 READERS AND CREDENTIALS

A. Card Readers:
   1. Card readers provided shall be proximity technology.
   2. Quantity and location of card readers shall be as specified in Contract Documents and the Drawings.
   3. Card readers shall be interfaced to the Controller.
   4. The reader shall read encoded data from the access card and transmit the data back to the host, giving an audible and visual indication of a properly read card.
   5. The typical read range shall be 1” to 4” when used with the specified card.
   6. Configuration shall be option-00 (Beep on LED normally red, reader flashes green on tag read).
   7. Manufacturer is DMP: Part No. PP6005B.

B. Access Cards:
   1. Access cards shall be compatible with the readers and run in sequences with the Owners active cards. Coordinate with Owner prior to ordering.
      a. Manufacturer is DMP access cards (Provide 200 cards)

2.5 KEYPADS

A. Provide, as shown on plans, UL listed keypads for allowing system control and operation.
   1. Arm/disarm by zones and system
   2. Annunciation by zone and system
   3. Trouble/supervisory alarm
   4. Alarm by assign ID Point
   5. Alarm History
   6. Arm/disarm instructions in English
   7. 32-character digital LCD display
   8. Real Time clock display
   9. Built-in speakers
   10. Manufacturer is DMP: Part No 7073ANEE-W

2.6 DOOR CONTACTS

A. Provide door contacts as shown on plans. Door contacts shall have the following specifications:
   1. UL listed 1” diameter magnetic door contact DPDT (double pole/double throw switch.
   2. Contact shall be self-locking for recessed mounting, natural color, close loop with 12” #22 AWG leads and 1” gap.
   3. Provide all hardware, mounting bracket, adapters and plates required for magnetic contact switch installation.
   4. Ge Sentrol Part 1076D-N or (approved equal or better)
   5. For overhead roiling door applications provide U.L. Listed heavy-duty SPDT (Single-pole-double-throw) surface mounted magnetic contacts with 3” minimum gap size.
      a. Manufacturer is Sentrol: Part No 2207AH or 2507AH series or (approved equal or better).

2.7 MOTION DETECTORS

A. Provide motion detectors as shown on the plans. Motion detectors shall have the following features:
   1. Dual technology adaptive sensor utilizing passive infrared and microwave technologies with multiple automatic detection modes.
   2. Voltage 9.0 to 15.0 VDC
   3. Current Drain: 16 Ma @12 vdc
   4. Normally Closed reed relay rated at 3.0 watts, 125 Ma @ 28vdc WITH INTERNAL 4.7 OHM current limiting resistor in the common “C” leg.
   5. Dimensions: 5” H x 2.8”W x 2.2 D
   6. Trouble output

7. UL listed, FCC Certified
8. High Impact ABS plastic enclosure
9. Provide gimbal mounts and accessories as required for the installation of the motion detectors.
    a. Manufacturer is Bosch
        1) Short Range Motion Detector: Part No DS950
        2) Mid-Range Motion Detector: Part No DS970
        3) Long Range Motion detector: Part No DS794Z

2.8 CABLING

A. Provide UL listed power limited cables under NEC 725 Class II wiring where required.

B. Minimum 18 AWG solid copper conductors for power connectivity.
    1. The security access control system installer shall provide cabling from all access control. Device locations. Terminations at the device and end shall be provided by the access control system installer. All access control head-end cabling terminations in the MDF to be terminated by the access control contractor. Coordinate additional cabling requirements, other than those listed below, for access control devices with the access control system provider shop drawings.

C. Twisted pair cable shall be used to prevent EMI/RFI interference with the proper operation of the security circuits.

D. Cabling shall be UL910, NFPA 262, CMP (plenum), rated unless otherwise noted.
    1. Manufacturer is Belden or approved equal

2.9 REQUEST TO EXIT

A. Provide REX detector as shown on the plans. REX detector shall have the following features:
    1. 8-feet x 10-feet coverage
    2. Adjustable coverage
    3. Door Monitor with sounder alert.
        a. Manufacture is Bosch, Part No DS160

2.10 SPARE PARTS DATA

A. After shop drawings are approved, and not later than thirty (30) calendar days prior to the date of beneficial occupancy, a list of spare parts data for each item of specified materials and equipment shall be submitted. The data shall include a complete list of parts and supplies with current unit prices and source of supply. Spare parts shall consist of, but not be limited to, five (5) percent of all initiating and notification appliances with a minimum of one (1) each. All spare parts shall be on site prior to commencement of acceptance testing. Depleted spare parts shall be replaced prior to beneficial occupancy.

2.11 OPERATING DOCUMENTS

A. The contractor shall furnish to the architect operating instructions outlining the step-by-step procedures required for system start-up, operation, and shutdown at least thirty (30) calendar days prior to acceptance test. The instructions shall include the manufacturer's name, system model number, service manual, parts list, and a description of all equipment and their basic operating features.
    1. Furnish three (3) complete sets of Owner's Operation and Maintenance Manuals and other information necessary for use and upkeep of the system.
    2. Upon completion of installation, prepare record drawings of the system. Drawings shall be floor plans indicating exact device locations, panel terminations, cable routes and wire numbers as tagged and color-coded on the cable tag. Final point-to-point wiring diagrams of each type of device shall be included in the record drawings.

3. Provide an electronic copy of all final record drawings on CD-ROM. Record drawings files shall be formatted in the most current version of AutoCAD

2.12 MAINTENANCE DOCUMENTS

A. The contractor shall furnish maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides at least 30 calendar days prior to acceptance test.

2.13 PERFORMANCE TEST REPORTS

A. Upon the installed system completion and testing, test reports shall be submitted in booklet form showing all field tests performed to prove compliance with specified performance criteria.

2.14 WARRANTY

A. A copy of the manufacturer's warranty for all equipment and materials shall be provided. Warranty shall be for all equipment, materials, installation, and workmanship for a minimum of three (3) years including labor and parts, unless otherwise specified and agreed upon by the Owner.
   1. Contractor warrants that all work furnished (material and labor under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.
   2. Contractor shall provide parts and labor guarantee on all Work. Unless otherwise specified herein. Contractor's guarantee shall be for a period of three (3) years from date of acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time. If standard manufacturer warranty period is less than 3-year period, and extended warrant shall be provided in the base bid to provide warranty coverage of 3 years.
   3. Contractor's guarantee shall cover all costs associated with troubleshooting, repair and replacement of defective work, including costs of labor, transportation, lodging, materials and equipment.
   4. Warranty response time shall not exceed four (4) hours.

B. Service/Maintenance:
   1. System maintenance and repair of system or workmanship defects during the warranty period shall be provided free of charge (parts and labor)
   2. Periodic testing of system shall be carried out on the quarterly basis during the warranty period to ensure the integrity of the control/communicator, the sensing devices, and telephone lines.
   3. Correct any system defect within six (6) hours of receipt of call from the Owner.
   4. Extended service/maintenance agreement shall be offered for up to four years after the warranty expires. The agreement shall be renewable annually.

2.15 MONITORING

A. Provide a supervised signal to notify the Owners' Monitoring Agency. Provide connections and interface equipment and programming as required. Coordinate installation of dialer equipment.

2.16 ZONING

A. The design intent is to provide two zones of security for the entire building. The Kitchen shall be zoned separately from the rest of the building. Prior to installation, verify exact zoning with the Owner.

B. For multiple zones, each shall have capability of being independently controlled (armed or disarmed) independent of other zones.

2.17 TRAINING

A. On-site security personnel training. Training in the complete programming, troubleshooting and operation of the systems shall be provided upon completion of installation. Provided a minimum of two sessions each of four (4) hours each.

2.18 TESTING AND ACCEPTANCE

A. After Work is completed, and prior to walk test, Contractor shall inspect and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.

B. In order to ensure the Owner and all contracting parties are in agreement, a formal acceptance procedure has been established for the security system. The acceptance of the system is based upon the successful completion of the testing requirements and is therefore not open to punch list items only. It is understood that the tests may be conducted over a period and therefore each test may be accepted individually. Final acceptance and release will be when all tests are completed and accepted. Failure of a test requires that a specific test be re-run but does not affect any test already accepted with the exception of the integrated Test. Failure of the integrated test may require the retest of one or more individual tests until all devices and software testing instruction is complete.

C. Confirm with the Owner's Monitoring Agency the required description of alarm points.

2.19 COMMISSIONING REQUIREMENTS

A. See the following Division 01 and 24 sections for all commissioning requirement related to the work of this section:
   1. Section with General Commissioning Requirements
   2. Section with-electrical systems commissioning

2.20 GENERAL COMPONENT REQUIREMENTS

A. Component Enclosure
   1. Housings; power supply enclosures, terminal cabinets, control units, and other component housings, collectively referred to as enclosures shall be so formed and assembled as to be sturdy and rigid. If sheet steel is used in the fabrication of enclosures, it shall be not less than an 18-gauge door with a 20 gauge box frame. Where exposed pins, the hinges shall be of the tight pin type or the ends of hinge pins shall be tack welded to prevent ready removal. Doors having a latch edge length of less than 24 inches shall be provided with a single lock. Where the hinged door latch edge is 24 inches or more in length, doors shall be provided with three-point latching device with lock; or alternatively with two locks, one located near each end. For SCIF and High Security applications an attack proof enclosure with proper tampers listed for use with the XR150/XR350/XR550 with Network and Encryption shall be used.

B. Electronic Components
   1. All system electronic components shall be solid-state type, mounted on printed circuit boards. Light duty relays and similar switching devices shall be solid-state type or electromechanical.
   2. The panel shall have an over current notification LED that lights when devices connected to the Keypad Bus and Loop Expansion LX-Bus(es) draw more current than the panel is rated for. When the over current LED lights, the Loop Expansion LX-Bus(es) and Keypad bus are shut down.

C. Control Unit
   1. A battery test shall be automatically performed to test the integrity of the standby battery. The test shall disconnect the standby battery from the charging circuit and place a load on the battery. This test shall be performed no more than every 180 seconds.

2. The control unit shall be capable of operating and supervising notification appliance devices as well as addressable initiating detection devices and an integrated supervised dual line digital communicator.
3. Control unit must be “Flash ROM” updatable, and program must be held in non-volatile RAM. The panel shall be able to function while the update is in process.
4. Control unit shall be capable of operating using an optional built in Encrypted Alarm Router for SCIF (Sensitive Compartmented Information Facility) application that is certified by NIST (National Institute of Standards and Technology) for 128-bit or 256-bit AES (Advanced Encryption Standard) Encryption communications.
5. The optional built-in Encrypted Alarm Router shall be capable of compliance with ICD 705 Chapter 7 Intrusion Detection Systems (IDS) and UL 2050 standards.

D. Remote Annunciators
1. The system shall support a maximum of sixteen (16) supervised remote annunciators with the identical capabilities, functions and display layout. Operation of the remote annunciators shall be limited to authorized users by the use of a code or key.
2. The remote annunciators shall be capable of operating at a maximum wiring distance of 15,000 feet from the control unit on unshielded, non-twisted cable.1`

E. Control Designations
1. Controls shall be provided to ensure ease of operation of all specified characteristics. Where applicable, clockwise rotation of controls shall result in an increasing function; controls, switches, visual signals and indicating devices, input and output connectors, terminals and test points shall be clearly marked or labeled on the hardware to permit quick identification of intended use and location.

F. Test Function
1. The system shall include a provision that permits testing from any alphanumeric keypad. The test shall include standby battery, alarm bell or siren, and communication to the central station.
2. The system shall include a provision for an automatic, hourly, daily, weekly, thirty (30) day, or up to sixty (60) day communication link test from the control panel installation site to the central station.
3. The system shall include a provision for displaying the internal system power and wiring conditions. Internal monitors shall include the bell circuit, AC power, battery voltage level, charging voltage, panel box tamper, phone trouble line 1, phone trouble line 2, transmit trouble, and network trouble.

G. Power Supplies
1. Power supplies for the control unit shall operate from 120 Vac, supplied at the respective protected areas. Standby batteries shall be supplied to power the system in the event of a utility power failure. Batteries shall be sized to provide 105% capacity for eight hours. Standby batteries shall be sealed lead-acid. Power supplies shall be all Solid State.
2. Controls shall be designed to maintain full battery charge when alternating current is available. Batteries shall be recharged to 85% capacity within 24 hours from battery use. The system shall be automatically transferred to battery power upon loss of alternating current power and return to alternating current power upon restoration. Intrusion alarms shall not be initiated during switch over; a signal shall be initiated upon failure of battery or alternating current power.
3. Approved power supplies shall meet or exceed the following power supply model specifications:
    a. UL Listed DMP 505-12: 12Vdc 5 Amp with transformer and enclosure.

H. Software
1. The system shall interface with computer software with the capability to fully program the panel by connecting to the panel through:
    a. Direct cable connection interface card
    b. Receiver phone line connection
    c. Standard phone line connection

d. Ethernet network connection
e. Network connection across the Internet
f. Cellular network connection using the 263C or 263H Cellular Communicators

2. The system shall interface with computer software capable of locking down all controlled doors.
3. The system shall interface with computer software capable of monitoring and logging all events.
4. The system shall interface with computer software capable of exporting reports in the following file formats:

EXCEL SPREADSHEET (*.XLS	TEXT (*.TXT)
RICH TEXT (*.RTF)	COMMA-SEPARATED (*.CSV)
WINDOWS METAFILE (*.WMF)	HTML DOCUMENT (*.HTM)
QUICKREPORT (*.QRP)	

5. The system shall interface with computer software capable of printing custom, filtered reports including:

ALL EVENTS	DOOR ACCESS GRANTED
ZONE ACTION	DOOR ACCESS DENIED
ARMING/DISARMING	OPENING/CLOSING SCHEDULE CHANGES
AREA LATE TO CLOSE	SYSTEM MONITORS
USER CODE CHANGES	SYSTEM EVENTS

I. Graphic User Interface (GUI)
1. Entré – Access and Security Management Software
2. System Features:
   a. The software shall be available:
      1) Entré Enterprise™: Shall have the same features as Entré Business with 96 doors included with the ability to expand to an unlimited number of doors, users and XR550 Series panels.
   b. Shall have simple user management, with the ability to import users from existing databases.
   c. Shall be able to assign user access by group, facility or other parameters.
   d. Shall have drop down lists for devices, user data and other information to facilitate fast and accurate searches.
   e. Shall be able to view system status in one of a variety of views for simplified alarm monitoring management.
   f. Shall have the capability to customize reports for added flexibility.
3. User Management:
   a. It shall have the ability to import into Entré from existing systems via standard comma-separated value (CSV) format files. It shall easily add new users, capture and edit their photo for badging or visual verification from within the application.
   b. User fields shall be fully customizable. Assign specific rights or events by user or by group. The software shall be able to create effective/expiration time for users, limiting access to only certain times of the day, and only certain days, or for only a defined period of time.
4. AES Encryption:
   a. Entré Enterprise shall support the XR550 Series with Encryption panel AES (Advanced Encryption Standard) strong data security for sensitive personnel and facility data.
5. Highly Customizable:
   a. All access and security system will be integrated in the Entre system and tested for functionality before sign off of system.
   b. The software shall be extensively customizable to create a system that matches the end user’s application’s needs.
   c. Shall define what events are considered “alarms,” and what response is required from the system operator.
   d. Shall be able to tailor user data with up to 20 available user-defined fields.
   e. All license will be provided by contractor.

6. Hierarchical Views:
    a. The software shall have the ability to select from four different system views, with the ability to have multiple views open simultaneously. Select the graphical Map view, tabular Event view, or hierarchical Tree view.
    b. The software shall be able to click on a device or alert to access additional information and process the event. In text-based views, software shall have simple drill downs to allow fast navigation to the desired item.
7. Powerful Search:
    a. The software shall employ industry standard SQL database for quick and easy search to identify any desired device or user which is compatible with nearly any database.
8. Single-System Control:
    a. The software shall employ a network solution to manage installations and users from any location. A single, unified database means there's one badge, one face or one fingerprint, worldwide.
9. Entré – Access & Security Management Software
    a. Optional System Modules:
        1) ENTRE-4DR Additional 4-Doors
        2) ENTRE-16DR Additional 16-Doors
        3) ENTRE-32DR Additional 32-Doors
        4) ENTRE-64DR Additional 64-Doors
        5) ENTRE-STD Standard Client
        6) ENTRE-WEB Web Client
        7) ENTRE-MAPS Alarm Graphics
        8) ENTRE-AUTO Automation Module
        9) ENTRE-DVR DVR Module
        10) ENTRE-PART Database Partitioning
        11) ENTRE-LANG Multiple Language module
        12) ENTRE-LDAP Lightweight Directory Access Protocol
        13) ENTRE-IMAGE Personnel Image Capture
        14) ENTRE-BADGE Badge Designer
        15) ENTRE-SIGN Signature Capture
    b. Optional System Modules Features:
        1) Shall be able to Point-and-click control of alarms and devices.
        2) Shall have a modular design to enable customization, with optional modules for added features.
        3) Shall be available in French, Spanish, or English, with dual- language operation mode.
        4) Shall have full reporting, including at-a-glance dashboard graphics and charts or traditional tabular displays, with the ability to produce reports in a variety of file types.
        5) Shall have NVR integration.
        6) Shall have image management of users and event photos.
        7) Shall have a custom badge builder and video badging.
10. Door Modules:
    a. The software shall allow for the addition of additional doors to support Entré Business or Enterprise systems.
11. Alarm Graphics:
    a. The software shall allow for the addition of additional doors to support Entré Business or Enterprise systems.
    b. Shall have the ability to give graphical representation of events and alarms at-a-glance and give feedback of system status.
    c. Shall have the capability to upload an unlimited number of graphical images of protected facilities in a variety of file formats.
    d. System maps are linked from level to level, allowing drill down from a macro view to a specific room or area.
    e. View alarm status at every level of zoom.

f. User-defined layers representing different alarm types allow you to customize the graphical interface to meet application needs.
g. Once loaded, it shall have the ability to plot alarm devices on the graphics using drag-and-drop selections from a hierarchical list of hardware. Identify the areas on your site maps, defining them by Classification, Entrances, Zones, and Partitions.
h. It shall have total picture-based monitoring and control of the system. It shall from facility-wide views be able to click to zoom in on any area of the facility and view the real-time status of any device.
i. The software shall be able to click on the alarm display icon to acknowledge an alarm or to request additional information

12. Automation Module:
    a. The software shall be able to give advanced users the power to create automated system actions.
    b. The software shall be able to define automatic responses to any system alarm or events. These include generating a report, generating an alert email, or sending commands to selected devices.
    c. Shall be able to create scheduled system actions to run once at a specified time and date, or scheduled events that repeat at user defined time and date intervals.
    d. System automation enables configuration of unattended activities, freeing system managers from many routine responsibilities.
13. CSR/NVR:
    a. The software shall be able to quickly connect to a NVR/CRS to review video based on a received alarm from a control panel.
    b. Connect to CSR/NVR from a graphical map of the area to review activity in Entre'.
        1) All NVR/CSR's must be updated to the current version of firmware at the time of installation.
        2) March Networks™
        3) 8000- Hybrid Series
        4) 8732 R-series
14. Database Partitioning:
    a. The software shall allow system information to be contained in a single unified database allowing system managers to limit user access to only certain areas of the database to partition the information.
    b. The software shall allow organization of data into separate collections by physical area, hardware types, events, or other parameters.
15. Multi-Language:
    a. The software shall support multiple languages enabling multiple operators to select a language during their login process. The software shall allow text shown both in English and a second selected language.
    b. Available languages shall include:
        1) English
        2) Spanish
16. LDAP (Lightweight Directory Access Protocol):
    a. The software shall provide LDAP single sign-on for users, enabling them to use one password to access multiple system services.
    b. System user information can be imported directly from an existing LDAP Tree.
17. Badge Image Capture:
    a. The software shall allow the transfer of pictures of users from a digital camera directly onto a badge. Select a TWAIN source to capture the image to allow up to date images on employee badges.
18. Badge Designer:
    a. The software shall have the ability to create one or more badge designs, customizing badges by facility, user level, or other parameters.
    b. When badging employees or visitors, select the desired badge template from library. The template automatically populates with the appropriate data, ready for printing.
19. Signature Capture:

a. Shall use a signature capture device to provide the ability to capture employee or visitor signatures and store the images.

20. Reporting Dashboard:
    a. The software shall have interactive graphics for instant feedback on system activity.
    b. The software shall be able to choose a number of charts for functions such as Access Granted /Denied at a particular access point or an entire facility to get a snapshot of activities within any defined time period.
    c. Shall have ability to filter through user, activity, or event data to narrow results and show precisely the information needed.
    d. Shall have the ability to view reports from within the application, or saved and exported to PDF, HTML, XLS, CSV, or XML format for distribution.
    e. Shall automate custom reports to generate and distribute each day at desired times.
21. Control Panel Capability
    a. The basic control panel shall provide:
        1) Expansion to a total of at least 10,000 user codes with 99 user profile definitions.
        2) Temporary user codes that can be entered with a finite date and specific time to expire.
        3) Sixteen (16) independent door/keypad addresses, each with four zones on XR550 and XR350, with eight (8) on the XR150.
        4) A total door access granted event buffer of at least 10,000 events.
        5) Anti-passback access control selectable by area and user.
        6) A total of at least 99 programmable Schedules for output relay schedules, area schedules, door schedules, holiday schedules, and user profiles. The same schedule may be assigned to more than one area, door, or output, making them reusable. There shall be at least two schedules per user profile with up to four profiles per user. Up to 8 Schedules per user, per door, per area, and per output.
        7) Eight Areas (8) individual reporting areas XR150, Sixteen (16) individual reporting areas XR350, and Thirty-two (32) individual reporting areas XR550.
        8) Built-in bell and telephone line supervision.
    b. The networked control panel shall provide the entire above plus:
        1) All of the above features plus.
            a) Require two-man access code or credentials. Require two user code entries to disarm and/or allow door access to this area.
            b) Support programming to require the same or different access code entered within a programmed delay time of 1 to 15 minutes after disarming before activating a silent ambush alarm.
            c) Early Morning Ambush. Must disarm a second time with in a programmed period of time or an early morning ambush silent alarm is sent.
            d) Bank Safe & Vault features. Schedules set for this area and the time of day cannot be changed while the area is armed.
    c. The XR550 encrypted control panel shall provide the entire above plus:
        1) All of the basic and network features listed plus.
            a) Built-in Encrypted Alarm Router.
            b) Certified operation that meets NIST (National Institute of Standards and Technology) standards for
            128-bit and 256-bit AES (Advanced Encryption Standard) Encryption.
            c) Certification that encrypted panel is capable of meeting ICD 705 Chapter 7 Intrusion Detection Systems (IDS) Standard.
            d) Certification that encrypted panel is capable of meeting UL 2050 standards.
            e) Card plus Pin for High security card access is provided by the Card Plus Pin feature that requires both a card read and a PIN (4-6 digit user ID) entry for arming/disarming and access by area. This Card Plus Pin operation complies with the ICD 705 requirement for dual id authentication and operates with a DMP Prox Keypad and a HID ProxPro reader with the keypad connected to a DMP Wiegand Interface module.

f) Panic Test allows the panic zone test verification and failure results to be sent to the central station receiver.
g) Passphrase of 8-16 characters to validate encryption between the XR550 with Encryption and the Central Station Receiver.

2.21 FUNCTIONAL DESCRIPTIONS

A. System Description
1. The system areas and zones shall be programmable, and the system shall store, log, display, and transmit specific custom designations for system areas, zones, and user names.
2. To ensure continued, one-call support, the system shall be constructed of sensing components provided directly by the system manufacturer, such as power supplies, motion detectors, door and window position switches, glass break detectors, or other sensing devices that the manufacturer offers.
3. The system controller, user interfaces, zone input devices, relay output devices, and the system signal receiving equipment shall be engineered, manufactured, assembled, and must be distributed from a location within the United States of America.
4. The system shall support user interaction by way of a keypad, web browser, system software, key switch, or radio frequency wireless control, Text messaging, or Smart Phone Application using integrated or auxiliary devices provided by the system manufacturer.
5. The system shall support controller zone input connections, system keypads, system zone expansion modules, and wireless zone input modules, and must support zone input connections by way of at least two competitive products. The system shall offer a seamless integrated compatibility with hard-wire and/or wireless zone expansion equipment for at least 500 wireless zones and/or a maximum of 574 hardwired zones.
6. The system shall be capable of offering up to five zone expansion buses, each of which can support the connection of up to 15,000 feet of four-wire cable. Zone expansion and keypad data buses that exceed 2,500 feet of cable must include splitter/repeater modules to boost data voltage and maintain data integrity.
7. The system shall provide a seamless capability to provide up to 506 addressable relays, which can be located at any connection location upon a zone expansion bus.
8. System relay outputs shall have the capability of being triggered as a result of a command from the user interface, changes in system status, changes in zone status, or by a programmable schedule.
9. System relay output states shall be programmable for momentary, maintained, pulsed, or must follow the state of an associated system zone input.
10. The system shall be completely programmable either locally from a keypad or remotely through a standard dial-up, and network connections by way of a LAN, WAN, and/or by way of the Internet, cellular communications paths.
11. The control unit shall be completely programmable remotely using remote annunciators, and/or using upload/download software that communicates using SDLC 300 baud, 2400 baud, or IP Addressed data network. On-site programming from a personal computer shall also be permitted.
12. The control unit shall be equipped with an anti-reversing circuit breaker to prevent damage due to accidental reversal of battery leads.

B. Input/output Capacity
1. This system shall be capable of monitoring a maximum of 574 individual zones and controlling a maximum of 506 output relays.
2. The control panel shall have, as an integral part of the assembly, 2 SPDT Form C relays rated at 1 Amp at 30 Vdc and four open collector 12 Vdc outputs rated at 50mA each. It shall also have the capacity of a maximum of 125 output expander modules with 500 switched ground, open collector outputs, 50mA maximum and 506 auxiliary relays (Form C rated at 1.0 Amp at 30 Vdc).
3. The panel shall also provide 99 programmable output profiles for schedules, and include an integral bell alarm circuit providing at least 1.5 Amps of steady, pulsed, or temporal bell output.

Output type shall be programmable by zone type. Relays and voltage outputs shall be capable of being independently programmed to turn on and/or off at selected times each day.

4. The system shall be capable of supporting and controlling up to 232 Z-Wave devices and up to 20 Z-Wave Favorites for group control.

C. User/Authorization Level Capacity
   1. The system shall be capable of operation by 10,000 unique Personal Identification Number (PIN) codes with each code having one (1) of ninety-nine (99) custom user profiles. This allows for limitation of certain functions to authorized users. The operation of all keypads shall be limited to authorized users.

D. Keypad
   1. The system shall support a maximum of sixteen (16) keypads on XR550/XR350 Series with alphanumeric display. Each keypad shall be capable of arming and disarming any system area based on a pass code or Proximity key authorization. The keypad alphanumeric display shall provide complete prompt messages during all stages of operation and system programming and display all relevant operating and test data.
   2. Communication between the control panel and all keypads and zone expanders shall be multiplexed over a non-shielded multi-conductor cable, as recommended by the manufacturer. This cable shall also provide the power to all keypads, zone expanders, output expanders, and other power consuming detection devices.
   3. If at any time a keypad does not detect polling; the alphanumeric display shall indicate “SYSTEM TROUBLE”. If at any time two devices are programmed for the same address, the alphanumeric keypad shall display “4 WIRE BUS TROUBLE”. If at any time a keypad detects polling but not for its particular address, the alphanumeric display shall indicate “NON POLLED ADDR”. The system shall display all system troubles at selected keypads with distinct alphanumeric messages.
   4. The keypad shall include self-test diagnostics enabling the installer to test all keypad functions: display test, key test, zone test, LED test, relay test, tone test, and address test.
   5. The keypad shall provide an easy-to-read English text display. The text shall exactly match the text seen in all software reports, keypad displays, and central station reports.
   6. The keypad user interface shall be a simple-to-use, menu-driven help system that is completely user friendly.
   7. The control panel shall support a keypad interface accessible on the World Wide Web in a browser window. The web-accessible keypad interface shall provide at least five (5) programmable hyperlinks for camera access or other use.

E. Zone Configuration
   1. A minimum of 4 Class B ungrounded zones shall be available at each keypad or zone expander on the system. The system shall have the capacity for a maximum of sixteen (16) keypads and a maximum of 125 four (4) zone expanders or 500 single zone expanders on the XR550. It shall also have the capacity of a maximum of 125 supervised relay output expanders. The XR350 shall have the capacity for a maximum of sixteen (16) keypads and a maximum of 125 four (4) zone expanders. It shall also have the capacity of a maximum of 75 supervised relay output expanders. The XR150 shall have the capacity for a maximum of eight (8) keypads and a maximum of 25 four (4) zone expanders It shall also have the capacity of a maximum of 25 supervised relay output expanders. All Class B zones shall be 2-wire, 22 AWG minimum, supervised by an end-of-line (EOL) device and shall be able to detect open and short conditions in excess of 500ms duration.
   2. Each zone shall function in any of the following configurations: Night, Day, Exit, Fire, Supervisory, Emergency, Panic, Auxiliary 1, Auxiliary 2, Fire Verification, Cross Zone, Priority, and Key Switch Arming.
   3. The digital SLCs and the annunciator/keypad bus shall be able to operate at a maximum wiring distance of 2500 feet from the control panel on unshielded, non-twisted cable. This distance may be extended to a total of 15,000 feet when bus repeater modules are installed.
   4. Each zone shall function in any of the following configurations:

NIGHT	SUPERVISORY	AUXILIARY 1	CROSS-ZONE

DAY	EMERGENCY	AUXILIARY 2	PRIORITY
EXIT	PANIC	FIRE VERIFICATION	ARMING
FIRE			

F. Communication
1. The system shall be capable of signaling to as many as 8 remote monitoring station receivers. Seven (7) of the eight (8) paths shall be capable of being assigned as either a “primary” or “backup” path. In such a manner the system shall have multiple primary paths to multiple remote monitoring stations as well as multiple backup paths to multiple monitoring stations.
2. The system shall employ Adaptive Technology that allows a Backup communication path programmed for Network or Cellular to automatically ADAPT to the faster check-in rate of the Primary path should the Primary path become unavailable. This creates a seamless transition for communication.
3. The system shall be capable of dialing up to (2) remote monitoring station receivers, four telephone numbers of 32 digits each using two separate switched telephone network lines such that if two unsuccessful attempts are made on the first line to the first number, the system shall make two attempts on first line to the second number. If these two attempts are unsuccessful, the system shall make two further attempts on the first line of the first number. After the tenth unsuccessful attempt, dialing shall stop and the alphanumeric keypad shall display trouble. Should another event occur that requires a report to be transmitted, the dialing sequence shall be repeated. The system shall have a programmable option to dial a second set of telephone numbers after the first ten attempts using the same sequence.
4. The system shall be capable of communication using the IBM Synchronous Data Link Control format, and at least one other standard industry format.
5. The system shall be capable of supporting Network communication with digital dialer backup, existing Ethernet data networks, satellite communication, fiber optic networks, local area networks, wide area networks, cellular communication, and retail data networks.

G. Network Communication
1. The control panel shall be capable of asynchronous network communication with a retry time between 2 and 240 minutes and a fail time of 2 and 240 minutes. If communication is unsuccessful the control panel shall be capable of attempting backup communication through any of the available communication methods to the same receiver or a backup receiver.
2. The control panel shall employee adaptive communication technology. Adaptive Technology allows a Backup communication path programmed to use Network or Cellular to automatically ADAPT to the faster check-in rate of the Primary path should the Primary path become unavailable, creating a seamless transition for communication of messages. Select Adapt when programming the Check in option. This allows a system to be fully supervised even if a path fails, while also keeping wireless charges low when the network is good.
3. Network communication between the control panel and the receiver shall be in a proprietary communication format.
4. The control panel shall be capable of supporting Dynamic Host Communication Protocol (DHCP) Internet Protocol (IP) addressing.
5. Underwriters Laboratories (UL) shall list network communication by the control panel for Standard or Encrypted Line Security.
6. The control panel shall be capable of two-way network communication using standard Ethernet 10/100 BaseT in a LAN, WAN, or Internet configuration.
7. The control panel shall be capable of communication by means of a 128-bit or 256-bit AES (Advanced Encryption Standard) Encryption process certified by NIST (National Institute of Standards and Technology) to an SCS-1R receiver with an SCS-104 line card or SCS-VR (SCS-VR currently supports 128-bit encryption only).
8. The control panel shall be capable of meeting ICD 705 Chapter 7 Intrusion Detection Systems (IDS) and UL 2050 standards.
9. The control panel shall be capable of sending text messaging to up to three Cellular Phone Numbers using cellular communications.

10. The control panel shall be capable of sending the following SMS messages:

ZONE ALARMS BY ZONE NAME	AC POWER TROUBLE AND RESTORAL
ZONE TROUBLES BY ZONE NAME	SYSTEM LOW BATTERY
ZONE BYPASS BY USER	AMBUSH
ARMING (CLOSINGS) BY USER	ABORT, CANCEL AND ALARM VERIFIED BY USER
DISARMING (OPENINGS) BY USER	CHECK-IN BY USER
LATE TO CLOSE	

H. Cellular Communications
1. The control panel shall have the capability to communicate with a plug-in cellular HSPA+ communicator model number 263H or CDMA communicator model number 263C that shall plug into the control panel J24 connector which shall supply full data communication and power to the 263H or 263C cellular communicator. The cellular communicator shall be capable of communicating full panel alarm and auxiliary messages to the DMP SCS-1R Central Station or SCS-VR Receiver as well as SMS text messaging to a PC, PDA, or Cellular telephone.
2. Building lockdown shall be initiated by cellular communications through the DMP “My Virtual Keypad Phone Application”:
   a. 734 module required to initiate lock-down & send notification through DMPVK App to PSD representatives
   b. Entre door license required for access control.
   c. Coordinate with PSD to open required ports on network for DMPVK App
   d. Tie into existing monitoring of security & access control systems by Moon Security Services, Inc.
   e. 2 hours total of training included for PSD representative on DMPVK App
3. The control panel shall be capable of sending the following SMS messages

ZONE ALARMS BY ZONE NAME	AC POWER TROUBLE AND RESTORAL
ZONE TROUBLES BY ZONE NAME	SYSTEM LOW BATTERY
ZONE BYPASS BY USER	AMBUSH
ARMING (CLOSINGS) BY USER	ABORT, CANCEL AND ALARM VERIFIED BY USER
DISARMING (OPENINGS) BY USER	CHECK-IN BY USER
LATE TO CLOSE	

I. TCP/IP Network Trapping
1. The control panel shall be capable of having communication set to Network operation. When a trap is set in Remote Link, the software shall be capable of sending a panel trap message with the panel account number to the SCS-104 installed in an SCS-1R receiver.
2. The receiver SCS-104 shall store the trap and monitor the panel for the next message. When the panel sends its next message, the receiver SCS-104 shall then send a message to the panel to contact Remote Link at the IP address contained in the original trap message.
3. The trap message shall be stored in the receiver SCS-104 for up to four hours. If the trap message is not sent to the panel within the four-hour window, the panel trap message shall be discarded and a new trap message must be sent from Remote Link.
4. The user shall be able to view the trap status in the receiver SCS-104 in Remote Link using the Trap Query function.

2.22 INTEGRATED INTRUSION ALARM AND ACCESS CONTROL OPERATION

A. Access Authority Levels
1. The system shall be capable of programming access credentials authority levels to check whether the user has access to a specific area and also has the authority to disarm or arm the area. If the user access credential has access and disarm/arm authority the system shall provide the user the option to disarm the area simultaneously upon opening the door, or to

open the door and begin an entry delay timer. With the timer option the user then disarms the area using an intrusion control keypad inside the area. If the user only has access authority to the area and the area is in an armed condition, the user is denied access to the area.

B. Door Open Schedule Override
   1. The system shall be capable of programming certain area doors to be scheduled to unlock and lock at specific times of the day or night. The lock/unlock function shall be capable of an override option depending upon the area armed/disarmed status. If the area remains in an armed status at the scheduled unlock time the armed status overrides the unlock schedule ensuring the doors remain locked and armed in situations where the business might open late, close early, is affected by inclement weather, or another emergency.

C. Common Area
   1. The system shall be capable of programming a common area to be armed when the last area in the system is armed and disarmed when the first area in the system is disarmed. To ensure the common area works properly it shall not have any user codes assigned to the common area. The system shall also be capable of programming multiple common areas.

D. Area Access Control
   1. The system shall be capable of integrating area access control capability where specified into the same control panel with the ability to have up to 10,000 user credentials. User access is limited to custom profiles and/or schedules. Anti-pass back shall be available. The networked version shall support a Two-Man Rule feature. The system shall support up to sixteen (16) access doors, connected to the system using a manufacturer-approved interface module.
   2. Area door access products shall meet or exceed features offered by the following products:
      a. Keypad reader/administration device – DMP Model 7063/7063A, 7073/7073A, 7163/7173, 7872, 7873
      b. Wiegand Interface – DMP Model 734, 734N, or 734N-WIFI
      c. Reader – DMP Model PP-6005B, Model PR-5455, Model MP-5365
      d. Cards or credentials – DMP Model 1326, DMP Model 1306P, DMP Model 1346, DMP Model 1386

E. Access Control Equipment
   1. Access Control equipment shall communicate to the system by way of the control panel keypad bus. The equipment shall have a three (3) year warranty and meet or exceed features offered in the products listed in Section 11.5 of this document.

F. Early Morning Ambush (XR550 only)
   1. The system shall be capable of programming an area to require two user codes be entered within a programmed number of minutes to prevent an ambush message from being sent to the Central Station Receiver. If both user codes are not entered within the time an ambush message is sent to the central station receiver.
   2. Both user codes shall have the authority to disarm the specific area and must be entered at the same keypad or reader. The keypad shall not display any indication that the ambush timer is running.
   3. The system shall be capable of programming an output to provide an external indicator that an ambush situation is taking place.

G. Two-Man Rule (XR550 only)
   1. The system shall be capable of programming an area to require two separate user codes be entered in order to disarm and/or allow access to a specific area. Both required codes shall have at least the same or greater authority level. Both required codes shall be entered within 30 seconds or an alarm shall activate.

H. Lockdown Button Summary Test
   1. The system shall provide to test lockdown buttons without sending a lockdown alarm to the Central Station Receiver.
   2. The system shall provide lockdown zone test verification and failure results to the Central Station Receiver.

3. During the test, each time a lockdown zone trips, the display number shall increment and the keypad buzzer sound for two seconds.
4. The number of lockdown zones tripped shall constantly display until the test ends or no lockdown zone activity has occurred for 20 minutes.
5. When the lockdown Zone Test ends and a zone failed (did not trip) during the test, the keypad shall be able to display the zone name and number and have the buzzer sounds for one second. Additional zone failed zones shall display when a button is pressed.

I. One-man Walk Test
1. A special code is also available for installers to test the system. The One-Man Walk Test feature allows a single technician to check the panel response to burglary and supervisory zones.

J. Multi-lingual Display Option
1. The system shall be programmed to display the User Menu and Status Display text in multiple languages.

K. User Inactivity Audit
1. System shall allow user code inactivity to notify the central station after a programmable period of days of no activity. The system shall be programmable from 0-365 days.

L. Lockdown
1. The system shall for emergency situations, provide a lock down command which can be issued from the keypad menu or via remote button command or from a cellular phone or a wireless FOB.
2. Initiation of a lockdown shall automatically notify the monitoring agency, lock all doors with electronic hardware, release magnetic holders, lower motorized gates, windows and send a group email signal/notification.

M. Communication Function Diagnostics
1. The system shall have enhanced diagnostic menu that enables technicians to check network and cellular communication status and cell signal strength from the keypad.

2.23 FALSE ALARM REDUCTION FEATURES

A. The system shall be capable of providing false alarm reduction features, functions, capabilities, or processes that either require alarms be verified or potential alarms be corrected before a system or zone can be placed into an armed state.

B. Exit Error Alert and Reporting
1. The panel shall be able to provide an automatic function to prevent a false alarm from occurring if an exit door does not properly close after the system is armed.

C. Entry and Exit Delay Annunciation
1. When arming, the system shall provide clear annunciation indicators to the user about the need to exit the premises prior to the exit delay time expiring.
2. When disarming, the system shall notify the user the need to disarm the system prior to the entry delay time expiring.

D. Remote Annunciation
1. The system shall be able to provide entry and exit delay time period notification. This notification can be from DMP keypads, remote annunciators, or bell tests.

E. Abort Reporting
1. The system shall be capable of sending an Abort report to the central station if the system is disarmed while the alarm is still sounding. The Abort report shall be sent after the alarm report to notify the central station that an authorized user has cancelled the alarm.

F. System Testing

1. The system shall offer testing features that are simple, quick, and complete and provide the highest measure of safety by ensuring that alarm conditions are detected and communicated to the proper authorities in a timely manner and on a regularly scheduled basis.

G. Ambush Code
   1. The system shall offer ambush codes for those dangerous encounters where the user is instructed to either arm or disarm the system under threat of harm. The duress code shall disarm the system without giving local indication of an alarm that might put the user well-being in jeopardy.

H. Two-Button Panic Feature
   1. The system shall support DMP keypads that provide the option to use only two-button panic codes. The user shall be required to press and hold two designated keys for approximately two seconds before the system generates a panic alarm.

I. Cross-Zoning Protection
   1. The system shall support cross-zoning as a means of requiring two device trips to occur within a short period of time before sounding an alarm and sending an alarm report to the central station. Supported device trips shall be from one device that trips two times, or from two devices that each trip once.

J. Swinger Zone Bypassing
   1. The system shall be capable of automatically bypassing a zone if it goes into an alarm or trouble condition a specified number of times within a one-hour period. The panel shall be able to track the number of times the zone trips while armed and compare that against a programmed number. When that number is reached, the panel shall be able to automatically bypass the zone. The panel shall be capable of resetting the zone when the area to which it is assigned disarms, is manually reset from the keypad or remotely, or remains normal for one hour.

K. Recently Armed Report
   1. The system shall be capable sending a System Recently Armed report, along with a zone alarm report, to the central station any time an alarm occurs within five minutes of the system arming. The System Recently Armed report allows the central station operator to follow a “call the subscriber first” procedure instead of immediately dispatching the police to what could be a false alarm.

L. Transmit Delay
   1. The system shall be capable of programming the panel to wait up to 60 seconds before sending burglary alarm reports to the central station. If an alarm is accidental, the user shall be able to disarm the system within the programmed Transmit Delay time. An Abort report shall be sent in place of an alarm report after the system disarms. During the alarm, sirens and panel relay outputs shall not be delayed and shall still provide local condition annunciation.

M. Call Waiting Cancel
   1. The system shall be capable of being programmed to cancel call waiting any time the panel dials the receiver number to send a report.

N. Cancel/Verify
   1. The system shall be capable of sending either a Cancel Report or Verify Report to the Central Station to signify that the end user has Canceled an Alarm or Verified an Alarm condition. Also the system shall be programmable to instead of Cancel/Verify show “IS THIS A FALSE ALARM? NO YES”. If YES send validation of alarm to Central Station, if NO send alarm cancels.

O. Must meet ANSI/SIA CP-01-2010 Standards for False Alarm Reduction
   1. The system shall be capable of meeting ANSI/SIA CP-01-2010 Standards for False Alarm Reduction.

P. Shall Meet Exit Delay Standards
   1. Default – 60 seconds (Minimum 45 seconds)

2. Progress Annunciation – different sound last ten seconds of delay
3. Automatic Restart of running exit delay, one time upon re-entry
4. Recent Closing – signal sent if alarm within 2 minutes of Exit time expiration (change from 5 min)
5. Exit Error – Immediate local alarm and entry delay starts

Q. Shall Meet Entry Delay Standards
1. Default – 30 seconds (Minimum 30 seconds)
2. Pre-Warning Silenced – after first digit code entry
3. Cancel Message sent if disarmed after alarm sent

R. Shall Meet Fail-to-Exit Standards
1. When perimeter and exterior areas are defined and the user does not leave the building before the system arms, the system only arms the perimeter and leaves the interior unarmed

S. Shall Meet Automatic Restart Standards
1. The system shall stop the Exit countdown once and restart it to allow the user to pick up a forgotten jacket or briefcase and exit the building without sending an alarm to the central station.
a. Graphical Site Maps
1) Entre'-Access and Security Management software
2) Optional system modules
a) Point and click control of alarms and devices.
b) Modular design enables customization, with optional modules for added features
c) Available in English and Spanish.
d) Full reporting with the ability to produce reports in a variety of file types.
e) DVR integrations
f) Event photos

2.24 BURGLARY CONTROL SPECIFICATIONS

A. Burglary Standards
1. The Burglary system shall be listed as a Power Limited Device and be listed under the standards below. Each system shall be supplied with complete details on all installation criteria necessary to meet all of the listings.

BURGLARY LISTINGS	CANADIAN BURGLARY LISTINGS
UL 1023 HOUSEHOLD BURGLAR ALARM SYSTEM UNITS	ULC C1023 HOUSEHOLD BURGLAR ALARM SYSTEM UNITS
UL 1076 PROPRIETARY BURGLAR	ULC/ORD-C1076 PROPRIETARY BURGLAR
UL 1610 CENTRAL STATION BURGLAR ALARM UNITS	ULC S304 CENTRAL STATION BURGLAR ALARM UNITS
UL 1635 DIGITAL BURGLAR ALARM COMMUNICATOR SYSTEM UNITS	
U.S. GOVERNMENT STANDARDS	
MEETS ICD 705 CHAPTER 7 INTRUSION DETECTION SYSTEMS (IDS)	
MEETS DOD/NIST SCIF STANDARDS	
MEETS ANSI/SIA CP-01-2010 FALSE ALARM REDUCTION	

B. Area System Mode
1. The system user shall be capable of selectively arming and disarming any one or more of 32 areas within the intrusion detection system based on the user PIN code and/or keypad used.

Each of the 574 zones shall be able to be assigned to any of the 32 available areas. The system shall be capable of having up to a thirty-two (32) character length name programmed for each area.

2. The system user shall be capable of assigning an opening and closing schedule to all areas or to each of the 32 areas separately. Each area shall be able to arm or disarm automatically by a schedule. The system shall have the capacity for common areas that automatically disarm when any other area disarms and that automatically arm when all others areas arm.
3. The networked system shall have the ability to comply with Bank Safe & Vault application. The networked system shall also have the ability to use a two-man rule for disarming or allowing door access to an area. The system shall have the ability to operate a Common Area application.
4. The Encrypted system shall have the feature of Card Plus Pin by area High security card access is provided by the Card Plus Pin feature that requires both a card read and a PIN (4-6 digit user ID) entry for arming/disarming and access by area. This Card Plus Pin operation complies with the ICPG 705 requirement for dual id authentication and operates with a DMP Prox Keypad and a HID ProxPro reader with the keypad connected to a DMP Wiegand Interface module.

C. Home/Sleep/Away Mode
   1. The system shall be capable of being configured in a Home/Sleep/Away configuration for Residential applications. The system shall consist of a Main House system and up to two Guest House systems within one single control Panel with each house being controlled with its own keypad as if it were separate alarm systems.

D. All/Perimeter Mode
   1. The system shall be capable of being configured into the All/Perimeter configuration to enable the selective arming of both the interior and perimeter when armed “All” or arming just the perimeter devices if arming “Perimeter”.

E. Zones
   1. The system shall have a minimum of eight (8) grounded burglary zones available from the control panel, and two floating ground powered zones for two wire type compatible smoke detectors. The system shall have the ability to expand using the panel’s keypad bus for up to sixty-four additional zones. The system shall also have five built-in zone expansion bus (LX500 – LX900) for an additional 500 zones of expansion. The system shall have the ability to integrate up to 500 wireless zones for a total of 574 zones overall.

F. Burglary Equipment
   1. Burglary detection equipment shall communicate to the system by way of the control panel loop expansion bus or 900MHz bi-directional spread spectrum receiver. The detection equipment shall have a three (3) year warranty and meet or exceed features offered in the products listed in Section 11.0 of this document.

G. Z-Wave Equipment
   1. The system shall be capable of 232 Z-Wave devices by means of the use of the model 738Z module. The system shall have the capability of up to 20 Z-Wave favorites for grouping Z-Wave devices into a favorite response or control.

2.25 ACCESS CONTROL SPECIFICATIONS

A. Access Control Standards
   1. The access control system shall be listed as a Power Limited Device and be listed under the standards below. Each system shall be supplied with complete details on all installation criteria necessary to meet all of the listings.

ACCESS CONTROL LISTINGS	U.S. GOVERNMENT STANDARDS
UL 294 ACCESS CONTROL SYSTEM UNITS	MEETS ICD/ICS 705 CHAPTER 7 INTRUSION DETECTION SYSTEMS (IDS)
	MEETS DOD/NIST SCIF STANDARDS

B. Keypad
   1. The system shall display a message at any keypad when any system area remains disarmed past the scheduled closing time. The message shall be displayed at one minute past the scheduled closing time. A pre-warn tone shall also begin sounding. If the system is not armed or a schedule extended within ten minutes past the scheduled closing time, the system shall provide the option of sending a Late to Close report to the central station.
   2. The keypad shall include a door strike relay capable of sending a report to the central station when activated.
   3. The keypad shall be capable of proximity arming and disarming functions.
   4. The keypad shall display red backlighting when in alarm condition notifying an individual of an unacknowledged alarm condition.
   5. The keypad shall annunciate when canceling an alarm condition the words “Cancel” or “Verify” to allow the end user the ability to cancel a user generated alarm or to select verify to send a message to the central station that the alarm has been verified by the end user and to send emergency response personnel. This is to comply with Alarm Verification.

C. Area Access Control
   1. The system shall be capable of integrating area access control capability where specified into the same control panel with the ability to have up to 10,000 user credentials. User access is limited to custom profiles and/or schedules. Anti-passback shall be available. The networked version shall support a Two-Man Rule feature. The system shall support up to sixteen (16) access doors, connected to the system using a manufacturer-approved interface module.
   2. Area door access products shall meet or exceed features offered by the following products:
      a. Keypad reader/administration device – DMP Model 7063/7063A, 7073/7073A, 7163/7173, 7872, 7873
      b. Wiegand Interface – DMP Model 734, 734N, or 734N-WIFI
      c. Reader – DMP Model PP-6005B, Model PR-5455, Model MP-5365
      d. Cards or credentials – DMP Model 1326, DMP Model 1306P, DMP Model 1346, DMP Model 1386

D. Access Control Equipment
   1. Access Control equipment shall communicate to the system by way of the control panel keypad bus. The equipment shall have a three (3) year warranty and meet or exceed features offered in the products listed in Section 11 of this document.

2.26 COMPILED DETECTION EQUIPMENT LISTING

A. Hard-wired
   1. Hard-wired detection equipment shall communicate to the system by way of the control panel loop expansion bus. The equipment shall have a three (3) year warranty as stated in the current DMP Product Catalog and meet or exceed features offered in the following products:
      a. Network Transient Suppressor – DMP Model 270
      b. Trouble Sounder – DMP Model 277
      c. Bus Splitter/Repeater Module – DMP Model 710
      d. Door Contact – DMP Model SM-20WG (surface applications – requires DMP zone expander)
      e. Output Expansion Module - DMP Model 716
      f. Graphic Annunciator Module - DMP Model 717
      g. Dual Phone Line Module – DMP Model 893A
      h. Other product types shall connect directly to zone expansion modules such as:
      i. Addressable - - DMP Models 521LX, 521LXT, 850S/711, 850D/711, 2W-BLX, 2WT-BLX
      j. Non-Addressable - DMP Models 521B, 521-BXT, 850S, 850D
      k. Addressable - DMP Model 711
      l. Addressable - DMP Models 714, 714-8, 714-16
      m. Addressable - DMP Models 712-8
      n. Addressable - DMP Models 715, 715-8, 715-16
      o. Manual Fire Alarms – DMP Models 850S, 850D

B. Wireless
   1. Wireless detection equipment shall communicate to the system by way of a compatible 900MHz receiver utilizing two-way communications, capable of receiving up to 500 wireless zones. The wireless system shall be programmed directly from the control panel, and shall not require a separate device programmer. The wireless detection equipment shall have a one (1) year warranty. It shall be capable of sending transmitter and battery status to the control panel's compatible receiver up to once every 60 seconds and must meet or exceed the following products:
      a. Wireless Receiver – DMP Model 1100X-W or 1100XH-W
      b. Wireless Repeater – DMP Model 1100R
      c. Universal transmitter – DMP Model 1101-W, 1102-W
      d. Universal Transmitter – DMP Model 1103-W
      e. Universal Transmitter – DMP Model 1105-W
      f. Wireless Window Transmitter – DMP Model 1107-W
      g. Wireless Zone Expander – DMP Model 1114-W
      h. Wireless Relay Output – DMP Model 1116-W
      i. Wireless LED Annunciator – DMP Model 1117R-B or 1117R-W
      j. Wireless Remote Indicator Light – DMP Model 1118R-B or 1118R-W
      k. Wireless Door Sounder – DMP Model 1119-W
      l. Motion Detector – DMP Model 1121-W, 1125-W, 1126R-W, 1126C-W, 1127W-W, and 1127C-W
      m. Glass Break Detector – DMP Model 1129-W
      n. Recessed Contact – DMP Model 1131-W
      o. Bill Trap – DMP Model 1139-I
      p. Panic Transmitter – DMP Model 1142-B, 1142-W, 1142BC-B, 1142BC-W
      q. Pendant Panic Transmitter – DMP Model 1145-1-B, 1145-2-B, and 1145-4-B
      r. Smoke Detector Transmitter – DMP Model 1161-W, 1162-W
      s. Wireless Smoke Detector – DMP Model 1165-W, 1165H-W, 1165HS-W
      t. Wireless Post Indicator Valve (PIV) – DMP Model 1181-R
      u. Wireless Outside Screw and Yoke Valve (OS & Y) – DMP Model 1182-R
      v. Wireless Heat Detectors 1183-135F and 1183-135R
      w. Wireless Carbon Monoxide Detector 1184-W

C. Power Supplies and Transformers
   1. Power supply and transformer shall maintain system operation. The batteries shall be checked and replaced every three to five years. The equipment shall have a three (3) year warranty as stated in the current DMP Product Catalog and meet or exceed features offered in the following products:
      a. Power Supply – DMP Model 505-12, 115 Vac, 12 Vdc
      b. Power Supply – DMP Model 505-12LX, 115 Vac, 12 Vdc
      c. Power Supply – DMP Model 505-12L, 12 Vdc
      d. Transformer - DMP Model 327, 16.5 Vac 50 VA, Plug-in
      e. Transformer - DMP Model 322, 16.5 Vac 56 VA, Wire-in
      f. Transformer - DMP Model 323, 16.5 Vac 56 VA, Wire-in
      g. Transformer – DMP Model 324, 16.5 Vac 100 VA, Wire-in
      h. Transformer – DMP Model 324P, 16.5 Vac 100 VA, Wire-in

D. Access Control Equipment
   1. Access control equipment shall provide access control functions between the panel and controller door access points. The equipment shall have a three (3) year warranty as stated in the current DMP Product Catalog and meet or exceed features offered in the following products:
      a. Interface Module – DMP Model 734, 734N, or 734N-WIFI Wiegand Interface Module
      b. Egress Module – DMP Model PB-2 REX Button
      c. Reader – DMP Model PP-6005B Proxpoint Plus©
      d. Reader – DMP Model MP-5365 Miniprox©
      e. Reader – DMP Model MX-5375 Maxi-Prox™

f. Reader – DMP Model TL-5395 Thinline II™
g. Door Controller – DMP Model 1306P Prox Patch™
h. Door Controller – DMP Model 1306PW Prox Patch™
i. Access Card – DMP Model 1351 ProxPass© Card
j. Access Card – DMP Model 1326 Proxcard II© Card
k. Access Device – DMP Model 1346 Proxkey II™ Keyfob, 1386 Isoprox II©

E. Cellular Communications Equipment
1. Cellular Communications equipment shall plug directly into the XR550 PCB J24 connector and shall be supervised by the XR550 control panel. The Cellular Communications Equipment shall be of a low current draw and powered directly by the XR550 Control Communicator.
2. The Cellular Communicator shall communicate in the SDLC Serial 3 Format for communications directly to a SCS-1R or SCS-VR DMP Central Station Receiver. The equipment shall have a three (3) year warranty as stated in the current DMP Product Catalog and meet or exceed features offered in the following products:
a. 263H Digital HSPA+ Digital Cellular Communicator
b. 263C CDMA Digital Cellular Communicator
c. 380-400 Level 400 SIM Card (263H only)
d. 381-2 18” Coax Cable
e. 381-12 12’ Coax Extension
f. 381-25 25’ Coax Extension
g. 383 Rubber Duck Antenna
h. 386 Wall Mount Antenna Bracket
i. 387-1 3DB Fiberglass Antenna w/Bracket
j. 387-3 3DB MEG Antenna
k. 387-4 SMA to N Cable, 4ft
l. 387-25 SMA to N Cable, 25ft
m. 387-50 SMA to N Cable, 50ft

F. Z-Wave Wireless Devices
1. The system shall be capable of 232 Z-Wave devices by means of the use of the model 738Z module. The following are compatible Z-Wave devices.
a. 738Z Z-Wave Module
b. Z-TZEMT400BB3X Z-Wave Thermostat
c. Z-45602 Z-Wave Light Control Module with Dimmer
d. Z-45603 Z-Wave Light Control and Appliance Module
e. Z-99100-004 Z-Wave Door Deadbolt, Polished Brass
f. Z-99100-005 Z-Wave Door Deadbolt, Satin Nickel
g. Z-99100-006 Z-Wave Door Deadbolt, Venetian Bronze

G. Wireless lockdown activation equipment
1. High power wireless receiver: DMP 1100XH
2. Single button wireless key FOB: DMP 1144-1 (Qty. 20)

H. Siren
1. Dual tone, steady and warble, impact resistant plastic, 15W, 105db, 12-16VDC. Model 335.

I. Lightning Suppression
1. The system shall include an optional lightning suppressor module that intercepts and directs lightning, transient, and RF interference to ground.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Submission of a proposal confirms that the Contract Documents and site conditions are accepted without qualifications unless exceptions are specifically noted.

B. The site shall be visited on a regular basis to appraise ongoing progress of other trades and contracts, make allowances for all ongoing work, and coordinate the requirements of this contract in a timely manner.

3.2 INSTALLATION

A. Pre-installation meeting: Prior to installation of access control, alarm and door framing, the contractor shall organize (and participate in) a pre-installation meeting that includes all Division contractors and equipment vendors who are involved in the installation. The purpose of this meeting is to clarify and verify that all components for a complete and operating system for access control/intrusion alarm and ADA power assisted door installations have been addressed and that responsibilities of work have clearly been defined and agreed upon by all participants. The meeting shall cover the following (but not limited to) topics:
   1. Rough-in requirements
   2. Rough-in locations
   3. Cable pathways into door frame
   4. Review of all materials provided by Division
   5. Power requirements
   6. Power supply locations
   7. Cabling requirements
   8. Final connections
   9. Schedule
   10. Programming
   11. Owner inspection and training

B. The System shall be installed and tested in accordance with the Manufacturer's Installation instructions. The following conditions are applicable:
   1. All necessary back-boxes, pull-boxes, connectors, supports, conduit, cable, and wire shall be furnished and installed to provide a complete and reliable System installation.
   2. All conduit, cable, and wire shall be installed parallel and square with building lines, including raised floor areas. Conduit fill shall not exceed forty percent (40%). All wires shall be gathered and tied up to create an orderly installation.
   3. Install the security intrusion detection system in accordance with the manufacturer's recommendations. Locate equipment and devices as indicated on the drawings.
   4. Installation of equipment and devices shall be coordinated with architectural features and the installation of door hardware equipment.
   5. Final connections between the equipment and the wiring system shall be made under the supervision of a representative of the system vendor/installer.
   6. Select cabinets and back-boxes to fit equipment and devices. Install plumb and aligned with building elements.
   7. Outside electrical rooms and telecommunications rooms, wiring and cable shall be installed in raceways or cable trays, except low-voltage cables run above accessible ceilings consisting of removable tiles. Raceways shall be grounded to the power system ground.
   8. Cables shall extend from the control cabinet to the device locations and between devices in uninterrupted continuous runs, without intermediate splices. Cables shall be free from shorts or grounds.
   9. Cables shall be routed so as to maintain a separation of at least 24" from all heat sources and from ballasts, transformers, dimmers and other sources of electromagnetic interference. Avoid exposed cables in occupied areas or in areas where they might be damaged as a result of normal use of the area. Where two (2) or more cables run in parallel, they shall be bundled with cable ties.
   10. Cables run exposed in accessible ceiling cavities shall be supported by means of suitable cable support devices from the building structure. They shall not lie upon the ceiling, nor shall they be supported from the ceiling frame, ceiling suspension wires, conduits, pipes, ductwork or lights. Supports shall be spaced no further apart than five feet on center.

11. Care shall be exercised during cable installation not to damage cable insulation. Damaged cables shall be removed and replaced. Type and spacing of supports shall ensure that cable will not kink or sag.
12. Cable shall be neatly dressed in the equipment rooms, without excessive slack. Cable path shall offer minimum obstruction to future installation. Avoid cables crossing horizontally through the areas just above or below riser sleeve or cable tray penetrations.
13. In each cable that terminates at an outlet or device, provide 12” of slack cable, neatly coiled, to facilitate future modifications.
14. Terminations shall be made in a neat and workmanlike manner.
15. All terminations, controls and outlets shall be clearly and logically labeled in accordance with the requirements in Section 26 05 33.
16. Personnel Door magnetic contacts shall be flush mounted in doors and door frames.
17. Motion detectors shall be installed on stainless steel device plates covering flush mounted outlet boxes with manufacturer supplied adjustable ceiling mounts for vertical orientation of the motion sensor.
18. Keypads shall be surface mounted over flush mounted outlet boxes.
19. Mount the Intrusion control panel/digital communicator in the location indicated and connect it via a telephone line to a Remote Reporting Agency for security system reporting in accordance with the Owner’s direction. The security intrusion detection system shall be connected to transmit alarm and trouble conditions by device and zone with the alarm signals having priority over other signals. The communicator output shall match the Remote Reporting Agency protocol and the available telephone dialing scheme.
20. Provide RJ31X jacks and wiring to interface the control panel to telephone lines for remote reporting. The RJ31X jacks shall be wired into the phone lines so that the control panel is the first device on the phone line, and off-normal panel conditions disconnect all downstream devices sharing the phone line. Program the control panel communicator using the communication protocol compatible with the UL-listed monitoring agent designated by the Owner.
21. Provide wiring to interface the security/access control panel to the cellular communicator. Provide an RJ45 CAT 6 jack and cable tied into the PSD network to be managed by a Certified Entre Installation company through Entre software.
22. Program the control panel communicator using the communications protocol compatible with the UL-listed monitoring agent designated by the owner.
23. Complete the connection to the monitoring account for the Owner. The control panel/digital communicator provided under this Contract shall remain the property of the Owner.
24. No power shall be applied to the intrusion detection equipment until all connections between the equipment and the wiring system have been checked for grounds, shorts, opens or other wiring defects, and approved by a representative of the equipment manufacturer.
25. Comply with all requirements of Section 27 15 00 “Communications Cabling.”
26. Provide one Category 6 patch panel in each IDF and MDF, or as required for the equipment network connections.
27. Terminate all Category 6 cables for the system.
28. Coordinate security zone configuration and access levels with owner.
29. Mount sirens 6” below ceiling or at 12’-0”, whichever is higher. Provide 16/2 riser cable for DC connection to DMP panel. Provide rough-in box with ½”C. sleeve into ceiling.

3.3 RACEWAY

A. Provide metallic raceways for cables installed in wall cavities, above inaccessible ceilings, locations without ceilings or other exposed locations.

B. The Contractor shall provide a complete design-build raceway and cabling system.

C. Any cable underground or under slab in raceway, shall be rated for wet location.

3.4 DEVICE BOXES

A. Provide appropriate back box, as suggested by manufacturer, at each card reader location.

B. Provide the manufacturer back box for the door controller.

3.5 PROGRAMMING

A. The intrusion detection system shall be programmed by an authorized manufacturer's representative to function as specified under the description of system operation, including the interface to the digital communicator and zone assignments. Programming shall comply with direction received from the Owner's Representative or Architect. Floor Plan shall be installed in the PSD Entre System by a Certified Entre installation company for them to control and manage.

B. Program output to the networked lighting control system to automatically turn on the corridor lighting upon badge in.

C. Program the system to initiate lockdown upon activation of the pushbutton located in the Administration, from the keypad or via a cell phone application.

D. Divide the system into the areas indicated on the shop drawings. Program each keypad to activate and deactivate each area by entering separate entry codes. Use codes provided by the Owner. Each keypad shall be capable of activating/deactivating each area individually and activating/deactivating all areas simultaneously.

E. Final system programming shall reflect room numbers/names as selected by the Owner or Architect. Room numbers shown on plans are architectural designs numbers for construction purposes. These numbers shall not be used for programming unless specifically directed by the Owner or Architect.

F. Program relays to interface to portions of the building lighting system. One relay shall function to turn off all interior lighting upon a valid credential presentation to ARM the building at a keypad. Another relay shall function to turn on all interior corridor lighting upon an ALARM condition created by intrusion. Relays shall be able to be turned ON/OFF from a keypad by someone having the proper system authorization attached to their passcode.

G. Main entry outer door: Program to be un-locked during scheduled school hours. Interior vestibule shall be always locked. During scheduled school hours this door shall be card accessible by staff and manually released for visitors by reception staff. After hours program both the outer and interior vestibule doors to un-lock upon card access.

H. Playground access door shall be programmed to be un-locked during scheduled recess periods.

I. All exterior except the main entry and playground access doors as described above, shall be card accessible only.

J. Coordinate all programming times with owner staff.

K. Program digital communicator to communicate with the remote reporting agency; Moon Security.

L. Program the wireless lockdown key FOBs to match receiver.

M. Submit documentation of system programming.

3.6 ADJUSTMENT, TESTING & DEMONSTRATION

A. Supply tools, instruments, gauges, testing equipment, protective devices and safety equipment for adjustment, testing and demonstration.

B. During adjustment and testing, carefully record all settings and all test results, including expected test results, actual test results, and corrective actions taken. Records shall be submitted to the Architect's Consultant and included in the Operating and Maintenance Manuals.

C. Test all system cable after installation and prior to connection to equipment. Tests to be performed shall include, but not be limited to, the following:
   1. Conductor continuity.
   2. D.C. insulation resistance.
   3. Freedom from shorts and grounds.

D. Make adjustments as necessary to aim motion sensors and set sensitivity levels to provide proper area coverage in accordance with the direction of the Owner's Representative.

E. Test all system features for proper function. Tests shall be conducted by the manufacturer's authorized vendor/installer. Notify the Remote Reporting Agency prior to beginning tests. Tests to be performed shall include, but not be limited to, the following:
   1. Verify that the keypad functions properly to arm and disarm the system.
   2. Verify that the keypad functions properly to acknowledge/deactivate alarms and reset the system.
   3. Verify proper operation of battery backup by performing tests for 60 minutes with the normal AC power source disconnected.
   4. Verify the proper initiation of the trouble signal for disconnection of AC power.
   5. Verify the proper operation and range of coverage for each motion detector by entering the protected space from different directions with the system armed.
   6. Verify the proper initiation of the trouble signal for disconnecting a motion detector.
   7. Verify the proper operation of each door position switch by opening the door with the system armed.
   8. Verify the proper annunciation and display of each alarm and trouble condition.
   9. Furnish documentation that all alarm and trouble conditions were correctly reported to the Remote Reporting Agency.

F. Correct any deficiencies discovered as a result of the above testing, and completely retest the work affected by such corrections, with no additional compensation.

G. After the system has been completed, tested and is operating properly, the manufacturer's representative shall test and demonstrate by actual usage, the proper operation of each control device and system function in the presence of the Owner's Representative. Demonstration shall include repetition of selected field tests, as well as additional adjustment or testing required to demonstrate that the system performs in accordance with the operational description as specified herein and the Owner's operational requirements.

3.7 COMMISSIONING

A. Field tests shall be witnessed by the Commissioning Agent, the Electrical Engineer, or other party so designated in other sections of the project specifications.

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

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

D. Tests and Inspections:
   1. Visual Inspection: Conduct visual inspection prior to testing.
   2. Inspection shall be based on completed Record Drawings and system documentation.
   3. Factory-authorized representative shall demonstrate the system operation and performance to the Commissioning Agent, or other designated agent.
   4. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

3.8 DEMONSTRATION

A. Engage a factory-authorized representative to train Owner's maintenance personnel to adjust, operate, and maintain the ACS system.

3.9 ON-SITE TRAINING

A. Supply one (1) hour minimum of training for the Owner’s staff in operating the intrusion detection system. In addition, the Contractor shall supply one (1) hour minimum of further training for the Owner’s maintenance personnel regarding maintenance of the system. Training time shall be extended as necessary to satisfy the Owner’s Representative that all pertinent topics have been adequately covered.

B. The training shall be conducted after the Operating and Maintenance Manuals for the Project are completed and available for use during the training session.

C. Maintain a training sign-in sheet upon which participants in the training session, including the instructions, shall record theirs names. The training sign-in sheet shall be dated.

D. Training shall be conducted by the manufacturer’s authorized vendor/installer of the equipment manufacturer who is thoroughly familiar with the equipment and its features, and with the Project. The training shall include instruction, field demonstration and over-the-shoulder hands-on training. As a minimum, the training shall cover, but not be limited to, the following topics:

E. General overview of access control and intrusion detection systems, including purpose and principle of operation.
   1. System features, including expansion capability.
   2. Interpretation of system outputs (indicators, displays, etc.).
   3. Arming and disarming the system.
   4. Acknowledging/deactivating alarms and resetting the system.
   5. Recommended maintenance procedures and intervals.

F. At the conclusion of the training session, insert a copy of the training sign-in sheet into the Operating and Maintenance Manuals. Submit another copy of the training sign-in sheet to the Architect.

3.10 AS-BUILT DRAWINGS

A. Comply with Division 28, Section 28 00 10, "General Provisions for Electronic Safety and Security Systems."

B. The contractor shall certify completion of the intrusion and Access Control systems installation and testing in accordance with the plans and specifications. Any original copy of the Record of Completion shall be delivered to the Owner’s Representative and photocopies shall be included in the O&M manuals.

3.11 OPERATING DOCUMENTS

A. The contractor shall furnish to the Owner, operating instructions outlining the step-by-step procedures required for system start-up, operation, and shutdown at least thirty (30) calendar days prior to acceptance test. The instructions shall include the manufacturer’s name, system model number, service manual, parts list, and a description of all equipment and their basic operating features.

3.12 WARRANTY

A. The warranty period shall be as specified in the General Conditions, but not less than one (1) calendar year from the date of project final completion. The intrusion detection system equipment

vendor shall warranty the all intrusion detection system equipment to be free from defects in materials and workmanship. The installing Contractor shall warranty all wiring and installation devices to be free from defects in materials and workmanship. The warranty shall cover the full cost of all repairs and all replacement costs for all system components. The equipment vendor and installing contractor shall have the option to repair or replace any system component. This warranty shall not be pro-rated, and there shall be no deductible amount.

END OF SECTION 28 31 13

SECTION 28 3173 - DISTRIBUTED ANTENNA SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Description
   1. The scope of the work provided under this specification shall include the following:
      a. Signal strength measurements after building is totally enclosed
      b. Conduit & junction boxes for donor and distribution antennas
      c. Material and labor to install a complete system
      d. Testing of installed system
      e. Approval from the AHJ & first responders
   2. The scope of this work shall include testing of the radio frequency signal strength within the building once the building is totally enclosed; roof, exterior walls and exterior wall glazing installed, to determine if the DAS is necessary. The Distributed Antenna System shall be provided if the radio frequency testing indicates that a DAS system is required. The contractor shall include the cost of the signal strength testing in their bid. At the direction of the owner, the signal strength testing shall be performed by Day Wireless Systems, Pasco, WA. 509-547-8502. Two signal strength test measurements shall be taken, one at 80% project completion and the other at final completion.
   3. An allowance for the DAS system shall be included in the bid. See specification section 01 2100.
   4. The conduit and junction boxes for the DAS shall be provided in the base bid per Division 26 specifications and the rough-in materials indicated in part 2 of this specification section.
   5. Work exclusive of the allowance shall include the Radio Frequency testing and rough-in for the distribution and Broadband Donor antennas.
   6. Under the allowance for providing a Distributed Antenna System, the work shall include the design, installation and testing of a Distributed Antenna System (DAS). The installed system shall provide reliable two-way radio communications for the local Public Safety Network (PSN). Provide all labor, simulation modeling, calculation, materials, tools, equipment, appurtenances, and services necessary for a complete and operations system as described herein, and in accordance with provisions of Contract Documents.
   7. The DAS shall provide two-way coverage for the PSN listed below on all frequencies currently being used by the designated PSN.
      a. 100 MHz coverage - Pasco Police Department
      b. 100 MHz coverage - North County Fire Department

B. General Requirements
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to work in this section.

1.2 QUALITY ASSURANCE

A. All equipment provided to meet the requirements of this specification must be installed in accordance with and meet the requirements of the issue of the NEC in effect at the date of installation.

B. The system shall comply with Parts 15, 22, and 90, Federal Communications Commission Rules, pertaining to radiation limits and frequency usage.

C. All equipment provided that requires type acceptance as defined by Title 47 of the Code of Commission prior to installation.

D. Materials shall have a UL label, shall be FM approved, and shall have evidence of approval by the local authority when such approval is required.

E. Qualifications:

F. The Contractor shall have an emergency 24-hour phone number for emergency repair.

G. The Contractor shall have an office, staffed with qualified technicians within a 50-mile radius of the site.

H. The Contractor bidding the DAS system shall have a minimum of five years' experience in the design, construction, testing and servicing of systems of the type and magnitude specified herein. The Contractor shall have completed at least ten projects equal or larger in size to this project within the past three years.

I. The Contractor shall provide manufacturer certification that their personnel have been trained on the *passive* and *active* components being installed.

J. The Contractor shall provide documentation that all installation personnel are properly trained and experienced in copper or optical fiber cabling installation techniques, including the requirements of ANSI/TIA Standards.

K. The Contractor shall be a duly authorized distributor of the equipment being supplied, with full manufacturer's warranty privileges.

1.3 REFERENCE CODES AND STANDARDS

A. Installation Standards: Equipment and cabling installation shall comply with the following codes and standards. All publications must be of the latest issue and addenda:
   1. NFPA 70 – 2011 National Electrical Code (NEC®)
   2. NFPA 72 – 2009 National Fire Alarm Code
   3. 2009 International Fire Code
   4. Federal Communications Commission (FCC) – Title 47 of the Code of Federal Regulations, Part 90
   5. Federal Communications Commission (FCC) Rules, Parts 15 and 22.
   6. ANSI/TIA – 568 – C.0: Generic Telecommunications Cabling Standard (February 2009)
   7. ANSI/TIA – 568 –C.0: Commercial Building Telecommunications Cabling Standard Part 1: General Requirements (February 2009)
   8. ANSI/TIA – 568 – C.3: Optical Fiber Cabling Components Standards (June 2008)
   9. ANSI/TIA – 569 – C: Commercial Building Standard for Telecommunications Pathways and Spaces (May 2012)
   10. ANSI/TIA – 606 – A: The Administrations Standard for the Telecommunications Infrastructure of Commercial Building (November 2008)
   11. ANSI/TIA – J – STD – 607 – A: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications (October 2002)
   12. BICSI Information Transport Systems Installation Methods Manual, 6th Edition
   13. BICSI Telecommunications Distribution Methods Manual, 12th Edition

B. Requirements set forth by first-responder code, ordinance, or the PSN AHJ shall supersede the requirements described herein and shall be met in their entirety. It is the Contractor's responsibility to ensure that the DAS complies with local code, ordinances or requirements established by the PSN AHJ.

1.4 SUBMITTALS

A. Submit product data, Contractor qualifications, Scope of Work, Acceptance Test Plan and shop drawings under provisions of Division 01 for submittal requirements. All submittals shall be submitted at one time to the Owner Representative for approval. Partial submittals will not be considered.

B. Do not order equipment or start work until all submittals have been approved.

C. Contractor qualifications
   1. Contractor shall provide documentation certifying that Contractor is an authorized DAS system installer for the specified manufacturer and that all installation personnel are certified to install the DAS components and cabling infrastructure.
   2. Product Data:

a. Submit manufacturer datasheets for all active and passive components, including but not limited to the following:
3. Donor and Coverage Antennas
4. Coaxial Cable and Connectors
5. Splitters, Combiners and Couplers
6. Bi-Directional Amplifiers (BDA)
7. Optical Fiber Master Unit
8. Optical Fiber Remote Units
9. Enclosures
10. Batteries

D. Statement of Work (SOW):
1. The Contractor shall submit a SOW to be reviewed and approved by Architect/Engineer.

E. Acceptance Test Plan (ATP):
1. The Contractor shall submit an ATP to be reviewed and approved by Architect/Engineer.

F. Shop Drawings: Submit the following items:
1. Scale floor plans indicating cabling pathways and coverage antenna locations.
2. Donor Antenna, grounding and lighting protection details
3. Active component locations, layout and configuration and mounting details
4. Riser Diagram
5. Signal to Noise Interference Ratio (SNIR) Map
6. RF propagation modeling
7. RF link budget
8. Maintain a set of approved shop drawings on the job site, with revisions, acceptance and exception notations kept up to date.

G. Following submittal review by the Architect/Engineer and correction of deficiencies, with resubmittals and reviewed as necessary, submit the drawings and product data to the local AHJ for final review.

H. Closeout Submittals:
1. At completion of work comply with the requirements of Section 01 7700, deliver the following to the architect:
2. Record Drawings:
a. Prior to and as a condition of final acceptance, the Contractor shall submit record drawings for the approval of the Architect/Engineer. These documents shall be in accordance with the following.
1) The Record Drawings shall be the previously accepted submittal drawings, corrected to actual as-built conditions.
2) The Record Drawings shall include:
a) Updated information regarding signal levels as required for the Shop Drawings.
b) Locations of all BDA, antennas, and associated components.
c) Detailed cable schedules that describe all modules, connectors, terminations, cable pathways, and cable installations records, installed or modified in the course of the work performed.
d) Riser diagram showing conduits, junction boxes, terminal cabinets, cabling and devices.
3) Record drawings shall be submitted in AutoCAD® Version 2010 or newer versions of software, or as approved by the Owner, and in PDF format.
4) Provide an electronic copy of the record drawings in full-size PDF and Auto CAD format, on CD-ROM, in each O&M manual.
3. Installed System Test Results:
a. The Contractor shall conduct and submit, in writing to the Architect/Engineer, the results of all tests.
b. Submit accepted ATP report confirming specified coverage and performance requirements have been met.
c. Submit sweep-testing results for all coaxial cable runs.

4. Operation, Maintenance and Service Manuals:
    a. Prior to final acceptance, complete sets of operations, maintenance and service manuals shall be submitted for systems and equipment provided under this contract, including all software licenses. At a minimum, the manuals shall include the following:
        1) Complete maintenance instructions, control and wiring diagrams and troubleshooting instructions.
        2) System service instructions for Work which manufacturers recommend user service.
        3) Complete parts lists for each major item of equipment and/or system supplied under this section.
        4) Complete collection of manufacturers' product and catalog literature for equipment and systems installed under this contract.
        5) Manufacturers' warranties
        6) Operating characteristics, performance data, ratings, and manufacturers' specifications for each item of equipment or system.
        7) Name, address and telephone number for emergency and non-emergency service for each item of equipment or system.
5. Warranty Documents:
    a. Contractor's System Warranty
    b. Manufacturer's Warranty

I. Abbreviations and Acronyms

ACG	Automatic Gain Control
AHJ	Authority Having Jurisdiction
ATP	Acceptance Test Plan
AWS	Advanced Wireless Service
BDA	Bi-Direction Amplifier
BOM	Bill – Of – Material
BRS	Broadband Radio Service
BTS	Base Transceiver Station
CDMA	Code Division Multiple Access
C/N	Carrier – To – Noise Ratio
CSP	Cellular Service Provider
CTCSS	Continuous Tone – Coded Squelch System
CWDM	Coarse Wave Division Multiplexing
DAS	Distributed Antenna System
DWDM	Dense Wave Division Multiplexing
EBS	Educational Broadband Service
ESMR	Enhanced Specialized Mobile Radio
FCC	Federal Communications Commission
GUI	Graphical User Interface
GROL	General Radio Operators License
IDEN	Integrated Enhanced Digital Network
LMR	Land Mobile Radio
LTE	Long Term Evolution
MTBF	Mean Time Between Failure
NFPA	National Fire Protection Association
NMS	Network Management System
PCS	Personal Communications System
PSN	Public Safety Network
RF	Radio Frequency
RoF	Radio – over – Fiber
RoHS	Restriction – of – Hazardous Substances
RSL	Received Signal Level
SISO	Single – Input, Single – Output
SMR	Specialized Mobile Radio

SMS	Short Message Service
SNIR	Signal – To – Noise Interference Ratio
SNMP	Simple Network Management Protocol
SOW	Statement of Work
VSWR	Voltage Standing Wave Ratio

1.5 DEFINITIONS

Federal Communications Commission (FCC):	The United States government agency that is the controlling authority for Title 47 of the Code of Federal Regulations and other statutory issues regarding radio (wireless) communications in the United States of America.
General Radio Operator License (GROL):	A valid General Radio Operators License issued by the Federal Communications Commission in accordance with Title 47 of the Code of Federal Regulations.
Distributed Antenna System (DAS):	A system of bi-directional amplifiers, cables, power supplies, antennas and other ancillary equipment that allows radio signals to pass to and from the interior of a structure for the purpose of facilitating radio communications with public safety radio systems and cellular service providers.
Acceptance:	Expressed approval by the Owner
Active:	DAS components that require AC/DC power for operation
Carrier Approval:	Expressed approval to interconnect to the CSP macro network
Channel:	A path for an RF transmission between two points
Component:	A main system element of the DAS
Contractor:	The prime Contractor bidding the project
Passive:	DAS components that do not require AC/DC power for operation

1.6 SYSTEM REQUIREMENTS

A. Without replacing the Passive DAS Infrastructure, the DAS shall have expansion capabilities to support the following CSP and PSN frequencies. Any additional components required for system expansion shall comply with all specification of this section.

Service	Uplink	Downlink

Cellular	824 – 849	869 – 894
PCS	1850 – 1915	1930 – 1995
AWS	1710 – 1755	2110 – 2155
Lower 700 Band	698 – 716	728 – 746
Unpaired 700 Band	716 – 728	
Upper 700 Band	746 – 776	776 – 805
100 Band PSN	151 – 153	153 – 158
BRS/EBS	2496 – 2690	

Table 1 – CSP and PSN Frequencies

B. Broadband Active Distribution:
   1. Coaxial cable will be used for active distribution. In-line amplifiers are not allowed.

C. Supervision:
   1. The DAS shall have a Network Management System (NMS) capable of alarm, and remote monitoring, configuration and control of all active components.
   2. The status of the system shall be continuously monitored and capable of reporting of failure through the building fire alarm system.

D. The system shall include, but is not limited to the following components:
   1. Donor antennas
   2. Coverage antennas
   3. Bi-Directional Amplifiers (BDA)
   4. Coaxial cable
   5. Coaxial patch cords
   6. Coaxial splitters, combiners and couplers
   7. Enclosures
   8. UPS
   9. Proper grounding and bonding of cabling and all components.
   10. Any other equipment necessary to furnish, install, terminate and test a fully functional system.

E. Prior to installation Contractors shall confirm the channel count and frequencies with the AHJ. The Fire and Police departments are in the process of changing frequencies.

F. Upon commissioning, the DAS shall provide coverage for the PSNs listed below on all frequencies currently being used by the designated PSN in the given market.

Service	Uplink (TX)	Downlink (RX)	Description
100 Band	151.22 MHz	153.74 MHz	Pasco Police Department
100 Band	153.785 MHz	158.775 MHz	North County Fire Department

G. Donor signal for RF services are located at:
   1. 46-6-12.66 N & 119-7-43.57 W

H. CSP Requirements:
   1. On a per channel basis, the downlink RSL for each CSP frequency band shall meet or exceed the criteria in Table 1.

Parameters	Unit	Lower 700 MHz, BRS/EBS	Cellular, PCS, AWS, Commercial 800/900 MHz	Public Safety 100, 380 – 512, 700, 800 MHz
Minimum downlink receive signal level (RSL)	dBm	- 77	- 85	- 95

   2. Contractor shall confirm the channel loading and frequency bands for the CSP in-building coverage.
   3. Prior to installation, Contractors shall confirm the channel loading and frequency use in the serving area.

4. The Contractor shall be responsible for providing the CSP with information each CSP requires to approve interconnection of the DAS to the CSP's macro network.

I. Signal Strength
   1. The system shall provide minimal signal strength of -95 dBm in 95% of all areas on each floor of the building. The coverage areas shall include stairwells, elevators and mechanical attic.
   2. A minimum signal strength of -100 dBm shall be received by the PSN radio system when transmitted from within the building.
   3. The signal strengths shall be present at a 100% reliability factor at the -95 dBm level.

J. When approval of the DAS deployment is required by code or ordinance, the Contractor shall be responsible for facilitating the AHJ approval(s) per the requirements of the code or ordinance.

K. Requirements set forth by local code, ordinance, or the AHJ shall supersede the requirements described herein and shall be met in their entirety. It is the Contractor's responsibility to ensure that the DAS complies with local code, ordinances or requirements established the AHJ.

1.7 WARRANTY

A. Contractor Warranty:
   1. Contractor shall warrant the system performance as specified for 3 - years.

B. Manufacturer Warranty:
   1. Splitters, Couplers and Coverage Antennas: 5 – year limited warranty from date of system acceptance.
   2. Coaxial Cable and Connectors: 10 – year limited warranty form date of system acceptance.
   3. Active Components: 2 – year limited warranty form date of system acceptance.

C. Manufacturers Extended Warranty:
   1. The DAS shall be covered by a two – part certification program provided by a single manufacturer and that manufacturer's certified Contractor. The certification program covers a certified system defined as a DAS installation performed by a certified Contractor using components conforming to Part 2 following all the manufacturers' recommendations, installation instructions and best practices. Manufacturer shall administer a follow – on program through the Contractor to provide support and service to the Owner. The first part is an assurance program, which provides that the certified system will support current and future modulation formats in the frequency bands for which it is designed, during the 20 – year warranty of the certified system.
   2. In the event that the certified system ceases to support the certified application(s), whether at the time of ATP, during normal use or when upgrading to additional frequency bands, the manufacturer and Contractor shall commit to promptly implement corrective action.
   3. Manufacturer shall maintain ISO Quality Control registration for the facilities that manufacture the products used in the DAS.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. The basis of design for this specification shall be a DAS system manufactured by CommScope Andrews to establish a standard for quality and performance. Other manufacturers may be acceptable subject to the substitution process as specified in Division 01. The Contractor shall provide documentation that other proposed systems meet all the system quality, performance and warranty requirements included in this specification.

B. Reference the Technology Component System Matrix following the Division 28 specifications for an outline of materials that are CFCI, OFCI & OFOI.

2.2 BROADBAND DONOR ANTENNA

A. Broadband Donor Antenna shall feature a multi – band design, accommodating Cellular, PCS, LMR and AWS frequencies in a single small antenna.
   1. Electrical:
      a. Frequency bands, 698 – 960 MHz and 1710 – 2700 MHz.
      b. VSWR ≥ 1.8
      c. Gain: 698 – 960 ≥ 10.0 dBi, 1710 – 2700 ≥ 12 dBi
      d. Maximum input power: 100 watts
      e. Polarization: Vertical
      f. Front – to – Back Ratio: 698 – 960 ≥ 20 dB, 1710 – 2700 ≥ 20 dB
      g. Impedance: 50 Ω
      h. Azimuth Pattern: As proposed by the manufacturer to meet the performance specifications in this section.
   2. Mechanical:
      a. Radome material: UV – protected ABS
      b. Pigtail cable: RG58, plenum rated
      c. Connector: 50 Ω N Series Female
      d. Mounting: wall bracket
   3. Environmental:
      a. Temperature: -40 °C to +60 °C
      b. Lighting protection: Direct ground
      c. Waterproof Level: IP 66
      d. Wind Speed, maximum: 125 mph
   4. Manufacturer is Andrew CELLMAX-EXT-CPUSE or approved equal.

2.3 LIGHTNING ARRESTOR

A. Provide dual band integrated DC passing surge arrestor for 7/8” cable. Surge arrestor shall have bulkhead body style with 7-16 DIN Female interface. Surge arrestor shall support 806 – 960 MHz and 1700 – 2170 MHz operating frequency bands.
   1. Manufacturer is Andrew APTA5DC-BDF-DB or approved equal.

2.4 OMNI-DIRECTIONAL COVERAGE ANTENNAS

A. Omni-Directional Coverage antennas shall feature a multi-band design, accommodating multiple frequency bands in a single small antenna.
   1. Electrical Band 1:
      a. Frequency Band: 698 – 800 MHz
      b. VSWR: ≤ 1.8:1
      c. Gain: ≥ 1.5 dBi
      d. Maximum Input Power:
      e. Impedance: 50 Ω
      f. Beamwidth, Horizontal: 360° omnidirectional
      g. Beamwidth, Vertical: 80° nominal
      h. Return Loss: 10.9 dB
   2. Electrical Band 2:
      a. Frequency Band: 1710 – 2700 MHz and 800 – 960 MHz
      b. VSWR: ≤ 1.5:1
      c. Gain: ≥ 1.5 dBi @ 800 – 960 MHz and ≥ 5.0 dBi @ 1710 – 2700 MHz
      d. Maximum Input Power:
      e. Impedance: 50 Ω
      f. Beamwidth, Horizontal: 360° omnidirectional
      g. Beamwidth, Vertical: 65° nominal
      h. Return Loss: ≤ 13.9 dB
   3. Mechanical:
      a. Connector: 50 Ω N Series Female

b. Mounting: Thru-hole ceiling mount
c. Radome material: ABS, UV Resistant
d. Pigtail cable: KSR195, plenum rated

4. Environmental:
   a. Application: Indoor
   b. Operating Temperature: 40 °C to +60 °C (+40 °F to +140 °F)
   c. Relative Humidity: up to 100%
5. Regulatory Compliance/Certifications: RoHS 2002/95/EC
6. Manufacturer is Andrew CELLMAX-O-CPUSE or approved equal.

2.5 DIRECTIONAL COVERAGE ANTENNAS

A. Directional coverage antennas shall feature a multi-band design, accommodating multiple frequency bands in a single small antenna.
   1. Electrical Band 1:
      a. Frequency Band: 698 – 800 MHz
      b. VSWR: ≤ 1.8:1
      c. Gain: ≥ 5 dBi @ 698 – 800 MHz
      d. Maximum Input Power: 50W
      e. Impedance: 50 Ω
      f. Beamwidth, Horizontal: 110° nominal
      g. Polarization: Vertical
      h. Return Loss: ≤ 10.9 dB
   2. Electrical Band 2:
      a. Frequency Band: 1710 – 2700 MHz and 800 – 960 MHz
      b. VSWR: ≤ 1.5:1
      c. Gain: ≥ 5 dBi @ 800 – 960 MHz and ≥ 6.0 dBi @ 2170 – 2700 MHz and ≥ 8.0 dBi @ 1710 – 2710 MHz
      d. Maximum Input Power:
      e. Impedance: 50 Ω
      f. Beamwidth, Horizontal: 90° nominal
      g. Return Loss: ≤ 13.9 dB
   3. Mechanical:
      a. Connector: 50 Ω N Series Female
      b. Mounting: 4 – hole wall mounting plate
      c. Radome material: ABS, UV Resistant
      d. Pigtail cable: RG58, plenum rated
   4. Environmental:
      a. Application: Indoor
      b. Operating Temperature: 40 °C to +60 °C (+40 °F to +140 °F)
      c. Relative Humidity: up to 100%
   5. Regulatory Compliance/Certifications: RoHS 2002/95/EC
   6. Manufacturer is Andrew CELLMAX-D-CPUSE or approved equal.

2.6 BI-DIRECTIONAL ANTENNA (BDA)

A. The BDA shall be of modular design and use digital filtering to mitigate interference and accommodate multiple services for PSNs.
   1. Characteristics
      a. Operating Temperature Range: -33 °C to +50 °C
      b. Modular design with up to 4 frequency bands per 19” chassis
      c. Filtering: Digital
      d. FCC Part 90.219 Type Classification: Class A narrowband for LMR/SMR/ESMR frequency bands
      e. Remote alarming through SNMP or SMS using wireless modem
      f. Mounting Options: shall support rack, wall and pole mounting

g. Frequency Bands Supported: 380 – 512 MHz LMR, 769 – 806 MHz LMR, 806 – 869 MHz LMR/SMR/ESMR, 896 – 941 MHz LMR/SMR/ESMR, 824 – 894 MHz Cellular, 1710 – 1755 MHZ AWS, 1900 – 1950 MHZ PCS

2. Compliance:
   a. NFPA: The BDA shall comply with NFPA-1 2009 edition In-Building Public Safety Radio Enhancement Systems.
   b. FCC: Shall be FCC type certified.
3. Manufacturer is Andrew Node A or approved equal.

2.7 COAXIAL CABLING

A. Air Dielectric, Plenum Rated Cable:
1. Material Characteristics:
   a. Jacket: Halogenated, Fire Retardant
   b. Outer Conductor Material: Corrugated Aluminum
   c. Inner Conductor Material: Copper-Clad Aluminum Wire
2. Electrical Characteristics:
   a. Impedance: 50 ± 2.0 Ω
   b. Frequency Band: 1 – 8800 MHz
   c. Peak Power Rating: ≥ 40.0 kW
3. Mechanical Characteristics:
   a. Diameter Over Jacket: ≤ .627”
   b. Minimum Bending Radius: ≤ 5”
   c. One Time Minimum Bending Radius: ≤ 3”
4. Attenuation Characteristics:

Frequency (MHz)	Attenuation (dB/100ft)
150	≤ 0.848
450	≤ 1.53
800	≤ 2.105
2000	≤ 3.564

Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

5. Manufacturer is Andrew AL4RPV-50 or approved equal

B. Foam Dielectric Cable
1. Material Characteristics:
   a. Jacket: Halogenated, Fire-Retardant Polyolefin
   b. Outer Conductor Material: Corrugated Copper
   c. Inner Conductor Material: Copper-Clad Aluminum Wire or Copper Tube
2. Electrical Characteristics:
   a. Impedance: 50 ± 2.0 Ω
   b. Frequency Band: ½” Nominal: 1 – 8800 MHz, 7/8” Nominal: 1 – 5000 MHz
   c. Peak Power Rating: ≥ 40.0 kW
3. Mechanical Characteristics:
   a. Diameter Over Jacket: ½” Nominal: ≤ .630 in 7/8” Nominal: ≤ 1.1 in
   b. Minimum Bending Radius: ½” Nominal ≤ 5 in, 7/8” Nominal: ≤ 10 in
   c. One Time Minimum Bending Radius: ½” Nominal: ≤ 2 in, 7/8” Nominal: ≤ 5 in
4. Attenuation Characteristics: ½” Nominal

Frequency (MHz)	Attenuation (dB/100 ft.)
150	≤ 0.815
450	≤ 1.447
800	≤ 1.968
2000	≤ 3.251

Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

5. Attenuation Characteristics: 7/8” Nominal:

Frequency (MHz)	Attenuation (dB/100 ft.)
150	≤ 0.417
450	≤ 0.774
800	≤ 1.041
2000	≤ 1.683

6. Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

7. Manufacturer: Andrew LDF4-50A (1/2”), LDF4RK-50A (1/2” CATVR), AVA5RK-50 (7/8” CATVR) or approved equal.

C. Splitters, Combiners, Couplers, Coax Jumpers and Connectors:
   1. Manufacturer is Andrew or approved equal.

2.8 CONNECTORS

A. Provide 50 Ohm type N connectors for terminating ½” coaxial cabling specified herein.

B. Connector shall have a straight body style with an N Male interface.
   1. Manufacturer is Andrew L4TNM-PSA, or approved equal.

C. For 5/8” coaxial cable provide 50 Ohm type N male straight connectors
   1. Manufacturer is Andrew L4.5NM-RC, or approved equal.

2.9 CONDUIT/RACEWAYS

A. Provide all pathways including but not limited to; junction boxes, conduit, antenna mast, supports and core penetrations as required for the system.

B. Pathway for telecommunications cabling, including cable tray and open cabling supports shall not be used for emergency response systems.

C. Conduit shall be EMT, GRS or IMC. Provide 2” for roof host antenna. Provide 1.25” for interior distribution antennas.

D. Junction boxes shall be 12”x12” minimum for interior antennas and as indicated on the drawings for the roof antenna pathway.

2.10 DEVICE MOUNTING SUPPORTS

A. Cabling shall be installed in metallic conduit.
   1. Provide all hardware and hanger rod supports necessary for secure mounting to the structure. Follow manufacturer’s recommendations for quantity of cables supported.

A. Provide all accessories and mounting hardware required for a complete and working installation of open cabling supports.

2.11 ENCLOSURE

A. The Bi-Directional Amplifier and any other active amplifiers shall be located in a single enclosure.

B. The primary controls and amplifiers shall be mounted in NEMA 4X painted steel cabinets and shall be painted Fire Engine Red and shall bear the lettering “FIRE ALARM EQUIPMENT – DO NOT DISABLE” at least 1 inch high in white or yellow block letters.

C. The main equipment cabinet for the system shall also have a label indicating the name and a 24 hour contact telephone number for the maintainer under contract for the system.

D. Provide a 2 - hour rated NEMA 4X enclosure with lock to house the BDA, UPS and alarm reporter with all necessary ventilation.

2.12 POWER SUPPLY

A. The system shall be provided with an internal backup battery and charger system or a commercial uninterruptible power supply (UPS) to provide a minimum of 12 hours of system operation at full power output.

B. The batteries will be serviced in accordance with the service that is required for the fire alarm systems.

C. Primary power must have a supervised circuit provided for connection to the building fire alarm system for use as a system fault indicator.

2.13 CABLING IDENTIFICATION TAGS

A. Coaxial identification tags shall be self-laminating, write-on, rigid, non-adhesive, measuring 3.50: x 2.00", and with a vinyl material strength of 0.20". Attach the tags to the associated innerduct or directly to the cabling utilizing specified cable ties. The legend and nomenclature for cabling shall read "CAUTION; DAS CABLE". Each tag shall have sub attribute lines for "TYPE" and "COUNT".
   1. Manufacturer is ACP International:
      a. Coaxial cabling tags, Part No. VCT-201 (orange)

B. Cable tie shall be dome-top; barb type with stainless steel locking barb, material shall be Nylon 6.6 with a maximum width of .141.
   1. Manufacturer is Panduit:
      a. 6.1-inch length, Part No. BT1.5I-C0
      b. 8.0-inch length, Part No. BT2I-C0

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Contractor must examine areas and conditions under which DAS components are to be installed and notify the Owner's Representative, in writing of those conditions which are, in the Contractor's opinion, potentially detrimental to proper completion of the Work. The Contractor shall not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Owner.

B. It is the Contractor's responsibility to identify any issues that may prevent implementation of a DAS to meet the coverage requirements.

C. Examine pathway elements intended for cabling. Examine raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

D. The Contractor shall examine all rooms designated to house DAS equipment to ensure adequate space, power, environmental conditions, etc., to support a proper installation.

3.2 INSTALLATION

A. The Contractor shall install the DAS in accordance with the accepted SOW.

B. Install DAS components, including all hardware, connectors, etc., as required to comply with hardware manufacturer's written instructions, with recognized ANSI/TIA standards and other relevant industry practices, and the Contract Drawings and Specifications.

C. The system shall be installed to provide the coverage requirements as stated in these specifications and contract drawings.

D. The Contractor shall provide all labor, equipment and materials required for project coordination, troubleshooting, testing and documentation of the DAS elements required herein.

E. Hardware components and wiring shall be installed in a neat, workmanlike manner consistent with best industry practices.

F. Tighten connectors and housing fixtures as recommended by manufacturer.

G. Cable Conduit Support Installation:
    1. The Contractor shall furnish and install supports for cable conduit system.

H. Cable Installation:
    1. The Contractor shall provide all hand tools and test equipment required to install and test all cabling.
    2. Maintain the following distances between cabling and other building systems:
        a. One foot from light fixtures.
        b. Four foot from motors and transformers.
        c. Three foot from hot water piping or other mechanical equipment.
        d. One foot from electrical conduits, electrical equipment and other systems cables.
    3. Remove the minimum amount of cable insulation required to complete that cable termination.
    4. The cabling shall be run concealed in the base bid conduit system located above the ceiling spaces and exposed through Mezzanine.
    5. Run cabling in continuous runs from termination locations at equipment or outlet locations; splices are not permitted.
    6. Fire seal around cable conduits running through rated floors and walls in accordance with requirements of Section 078400.
    7. Install cables per manufacturer's recommendations including but not limited to maximum tensile loading and maximum bend radius.

3.3 RACEWAYS

A. Furnish and install floor penetrations, roof penetration, raceways, wall penetrations, pull boxes, junction boxes and masts with support under the base bid as shown on the electrical floor plans.

B. Conduits shall be run concealed except in the Mezzanine.

C. Junction boxes shall be located above the suspended ceiling systems on the first & second floors and shall be located to provide accessibility.

3.4 GROUNDING AND BONDING

A. All external antennas shall be provided with appropriate lightning protection in accordance with the appropriate sections of the National Electrical Code.

3.5 LABELING

A. General:
    1. Labeling shall be in accordance with ANSI/TIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure.
    2. All labels shall be permanent typewritten labels produced by a labeling machine.
    3. Labels shall be installed on all cabling at each end.
    4. All labels shall be located within 6 inches of cable termination and placed so they can be easily read.
    5. The font type for each label shall be Arial.
    6. All labeling shall be completed prior to the substantial completion date of the project.

3.6 SYSTEM TESTING

A. Coaxial Cabling Field Testing:
    1. All coaxial cabling, connections, and terminations installed by the Contractor or used to support the requirements of these Contract Documents shall be tested for VSWR, continuity, shorts, reversals and grounds, where applicable.

B. DAS System Testing:
   1. Testing shall be conducted under the direct supervision of a person holding a valid General Radio Operators License (GROL) as issued by the Federal Communications Commission. The resulting test report shall be signed by that person and the Serial Number of their FCC License shall be included with the signature.

C. Acceptance Test Plan:
   1. The Acceptance Test Plan shall describe the tests and procedures for on-site testing of the installed system. At a minimum, the testing shall address the following:
      a. Description of acceptance tests to be witnessed by the Owner's Representative for each element of the system. Such acceptance tests shall be successfully completed prior to the initiation of the 30 - day burn in period.
      b. Testing to be performed by the Contractor for each DAS element as a pre - cursor to the Owner's Representative witnessed tests and prior to the 30 - day field test to demonstrate proper operation.
      c. At the end of the successful burn - in period, the Contractor shall perform an acceptance test to demonstrate that the DAS conditions have not changed. The acceptance test shall not be completed until all Owner provided furniture is installed and equipment operational within the building. At the completion of this test, the Contractor shall notify the Owner's Representative that the DAS is under warranty for two (2) years in accordance with the provisions identified elsewhere in this section.
   2. Proof of Performance and Testing Methodology:
      a. Test requirements specified in this document shall be successfully completed prior to issuance of a Certificate of Occupancy and yearly thereafter. Also, testing with a successful result shall occur whenever a design change is made to the system, which changes the technical performance or coverage of the system.
      b. The test data provided shall include measured data for each point for all PSN communications systems (channels).
      c. Each floor of the structure that is a component of this project shall be divided into 20 grids of equal area. The center point of each grid shall then be pre-designated a test location. Additional test points shall be located at the mechanical rooms (heating, ventilation or air conditioning) internal to the structure and passenger and service elevators control (or equipment) rooms. On each floor of each structure only one test location may fail the test specified and still consider the test to have passed for the system. All public safety radio systems specified above shall be tested at each test location. The failure of any test location on any of the public safety radio systems shall be considered a failure of that location.
      d. The test receiver or field strength meter used to provide measurements during testing shall bear evidence of calibration within the last 12 months.
      e. The AHJ may request system testing whenever the AHJ believes system performance has degraded to unacceptable levels. At the discretion of the AHJ, spot tests may conducted if they believe the system performance has degraded to unacceptable levels. The Owner shall make the facility available for testing upon request during normal business hours.
      f. The system must be tested annually beginning one (1) year from the date of final acceptance testing. The cost of future annual testing will be done by the respective premises/system Owner.

D. The Contractor shall make any corrections needed to meet the performance requirements as stated in this document at no additional cost.

E. Final acceptance of the DAS will be based on the Contractor complying with the Statement Of Work as evidenced by the Contractor completing the following:
   1. Installation workmanship inspections witnessed by the Owner's Representative.
   2. Testing supported by complete and accurate test records.
   3. Coverage tests witnessed by the Owner's Representative.
   4. Initial acceptance test witnessed by the Owner's Representative.

5. Successful completion of 30 - day burn - in period.
6. Final acceptance test witnessed by the Owner's Representative.
7. Technical training.

F. The Contractor shall provide written notice to the Owner's Representative at least thirty (30) calendar days in advance of the initiation of final system acceptance testing. Included in the advance notice shall be three (3) copies of the approved test plans and procedures to ensure acceptance test monitoring personnel are familiar with the test, procedures and the expected results.

G. After successful completion of the initial acceptance test, the Contractor shall inform the Owner's Representative of the beginning of a 30 - day burn - in period. During this period, the Contractor must demonstrate to the satisfaction of the Owner's Representative that the DAS in operating fault free. Any failure of the DAS components shall restart the 30 - day burn - in period.

H. All tests including the 30 - day burn - in period must be successfully completed as a condition for Final Acceptance testing (to be witnessed by the Owner's Representative).

I. Final Acceptance Testing shall be completed a minimum of 14 days prior to Owner's submittal for Request for Occupancy.

J. Annual Testing:
1. The system shall be tested annually beginning one (1) year from the date of final acceptance testing. The cost of future annual testing will be borne by the Owner.
2. Amplifiers shall be tested to ensure that the gain is the same as it was upon initial installation and acceptance.
3. The Owner shall notify the AHJ in writing two (2) weeks in advance of when the annual test will occur and shall the AHJ by certified mail of the results of the test. Test records shall be retained on the inspected premises by the Owner.

3.7 MAINTENANCE

A. Prior to the final acceptance of the DAS elements, the Contractor shall provide preventive and "on - call" corrective maintenance services for all installed equipment. Qualified maintenance personnel shall respond on - site, if required, in no more than two (2) hours from the maintenance call. This service shall include all labor, material, travel expenses, and incidentals at no additional cost to the Owner.

B. During the above maintenance period, the Contractor shall maintain complete logs of all maintenance activities including service calls, preventive maintenance, component failures, etc. The maintenance logs shall be kept on - site and made available to the Owner's Representative upon request. Upon Final Acceptance, the maintenance logs shall become the property of the Owner.

C. Prior to, and as a condition of: Final Acceptance, the Contractor shall submit to the Owner's Representative recommended modifications, as appropriate, to the maintenance procedures and the spare parts lists based upon actual experience with the system.

D. Maintenance Service Contract
1. The Owner shall be required to have in place a maintenance contract with a competent technical support organization for 24 hour a day, 7 day a week, 365 days a year response. Response time shall not exceed 6 hours. The cost of this contract shall be borne by the Owner.

3.8 TRAINING

A. The Contractor shall provide training for elements of the DAS. Such training shall include management, operations and maintenance levels and shall be provided to individuals (maximum of 3) to be designated by the Owner's Representative.

B. Training shall be conducted by qualified personnel fully conversant on the equipment, materials, software, and over all operation of the installed elements.

1. Training shall be based upon as much hands-on training as is possible.
2. The Contractor shall provide all the necessary training aids and materials, which shall include written handouts.
3. All training shall be completed prior to Final Acceptance.

C. Times, locations and quantities of training sessions shall be subject to the Owner's Representative approval.

3.9 WARRANTY

A. The Contractor shall, as a condition precedent to the final payment provide a warranty tot the Owner certifying that all the contract requirements have been completed in accordance with the Contract Specifications and Drawings. The written warranty shall specifically address the following:
   1. The Contractor shall warrant all installed hardware for a period of three (3) years from the date of Final Acceptance. Where such warranties are provided directly from the equipment manufacturers, the Contractor shall formally transfer all such warranties tot eh Owner. In the event that any manufacturer customarily provides a warranty period greater than three (3) years or such extended warranties are required by the Contract Documents, the warranty shall be for the greater period of time.
   2. The Contractor shall warrant for a period of three (3) years from the date of Final Acceptance all defects or damages due to faulty materials or workmanship. Defects related to faulty workmanship, including all damages to surrounding work caused by such defects, shall be without delay, repaired to the Owner's Representative's satisfaction at the Contractor's own expense.

B. Warranty Work: When equipment and labor covered by the Contractor's warranty or by a manufacturer's warranty have been replaced or restored Work shall be reinstated for a period of time equal to the original warranty period and commencing with the date of completion of the replacement or restoration work.

C. Unless specifically allowed, in writing, by the Owner's Representative, the required warranty period for the DAS shall not start until the Owner grants written acceptance. No partial acceptance of the DAS will be granted.

END OF SECTION 38 31 73

Pasco Orion High School - Pasco School District No. 1
Technology Component Systems Matrix

System ID	Component ID	System Description	Contractor Furnished Contractor Installed (CFCI)	Owner Furnished Contractor Installed (OFCI)	Owner Furnished Owner Installed (OFOI)
1	**.00**	**Telecommunications Distribution System (27 15 00)**			
1	.01	Device conduit rough-in (wall & floor box outlets & ceiling WAPs)	**X**		
1	.02	Conduit & box rough-in	**X**		
1	.03	Open cabling supports	**X**		
1	.04	Wireless access points (WAP)		**X**	
1	.05	Category 6 cabling, outlets & jack ports (Including all IP based systems)	**X**		
1	.06	Category 6 cabling with direct connector to WAPs	**X**		
1	.07	Optical fiber back bone cabling between MDF & IDFs	**X**		
1	.08	Optical fiber back bone cabling between MDF & site cameras	**X**		
1	.09	IT equipment 4-post racks for telecommunications rooms	**X**		
1	.10	Patch panel equipment 2-post racks for telecommunications rooms	**X**		
1	.11	Outside plant pathway to property line and/or utility service structure	**X**		
1	.12	UPS in Telecommunication Rooms (4-post rack)	**X**		
1	.13	Power Distribution Units on Telecommunication Racks	**X**		
1	.14	Power receptacles for telecommunications rooms	**X**		
1	.15	HVAC cooling equipment for telecommunications rooms	**X**		
1	.16	IT grounding & Bonding infrastructure	**X**		
1	.17	Firestopping for IT pathways	**X**		
1	.18	Patch cords for patch panels			**X**
1	.19	Patch cords for station outlets			**X**
1	.20	Fiber optic breakout panels	**X**		
1	.21	Network testing & TIA/EIA certification	**X**		
1	.22	Media Converter cabinet for site cameras			**X**
1	.23	Fiber optic utility service conduit to building (fiber cable by utility)	**X**		
1	.23	Fiber optic utility service activation			**X**
2	**.00**	**IP Intercom Clock System (27 52 16)**			
2	.01	Device conduit rough-in	**X**		
2	.02	IP intercom clock combo device & device end patch cord	**X**		
2	.03	IP intercom clock specialty back boxes	**X**		
2	.04	IP clocks	**X**		
2	.05	Priority page relays modules	**X**		
2	.06	Informacast licenses			**X**
2	.07	Informacast software, servers and programming			**X**
3	**.00**	**IP Video Distribution**			**X**
4	**.00**	**Classroom Audio Visual System (27 51 17)**			
4	.01	Device conduit rough-in	**X**		
4	.02	Portable monitor			**X**

Pasco Orion High School - Pasco School District No. 1
Technology Component Systems Matrix

System ID	Component ID	System Description	Contractor Furnished Contractor Installed (CFCI)	Owner Furnished Contractor Installed (OFCI)	Owner Furnished Owner Installed (OFOI)
5	**.00**	**Sound & Long Throw AV Systems (Commons)**			
5	.01	Device conduit rough-in	**X**		
5	.02	Large venue long throw video projector		**X**	
5	.03	Large venue video projector mount and cage	**X**		
5	.04	HDMI device and cabling	**X**		
5	.05	Audio visual headend equipment and controller	**X**		
5	.06	Loudspeakers & mounting hardware	**X**		
5	.07	Wireless microphone system (hand held and wireless)	**X**		
5	.08	Amplification & mixing components	**X**		
5	.09	Equipment racks	**X**		
5	.10	Assistive listening system	**X**		
5	.11	Area Selection and volume control components	**X**		
5	.12	Analog speaker cabling & connectivity	**X**		
5	.13	Priority page relays modules	**X**		
5	.14	Bluetooth input	**X**		
5	.15	Testing, programming and training	**X**		
6	**.00**	**Telephone System**			
6	.01	Telephone devices (handsets)			**X**
6	.02	Telephone servers, programming, and licensing			**X**
7	**.00**	**Network System Components**			
7	.01	PC workstations and monitors			**X**
7	.02	Network electronics			**X**
7	.03	Network programming and scheduling			**X**
7	.04	Network servers, programming and licensing			**X**
7	.05	Ethernet switches (PoE and non-PoE)			**X**
8	**.00**	**Security - Access and Intrusion Detection System (28 31 13)**			
8	.01	Device conduit rough-in	**X**		
8	.02	Access & Intrusion Control Panels	**X**		
8	.03	Connection to electronic door hardware	**X**		
8	.04	Access readers & REX devices	**X**		
8	.05	Intrusion detection devices	**X**		
8	.06	Low voltage cabling, security devices and terminations	**X**		
8	.07	Connection to monitoring agency			**X**
8	.08	Testing, programming and training	**X**		
9	**.00**	**Security - IP Surveillance System**			
9	.01	Device conduit & hard surface box rough-in	**X**		
9	.02	Category 6 & fiber cabling, outlets & jack ports	**X**		
9	.03	IP surveillance cameras, ACT box RI & patch cords (device end only)			**X**

Pasco Orion High School - Pasco School District No. 1
Technology Component Systems Matrix

System ID	Component ID	System Description	Contractor Furnished Contractor Installed (CFCI)	Owner Furnished Contractor Installed (OFCI)	Owner Furnished Owner Installed (OFOI)
9	.04	Software, cameras and licenses			X
9	.05	Physical servers and storage			X
9	.06	Media converter enclosure with 120V power; pole mounted site cameras	X		
9	.07	Media converter (fiber to copper)			X
9	.08	Testing, programming and training			X
10	**.00**	**Distributed Antenna System**			
10	.01	Device conduit rough-in	X		
10	.02	Signal strength testing and report	X		
10	.03	System equipment & installation allowance	X		
10	.04	Headend equipment (included in bid allowance)	X		
10	.05	Host & distribution antennas (included in bid allowance)	X		
10	.06	Cabling and terminations (included in bid allowance)	X		
10	.07	Testing, programming and training	X		
11	**.00**	**eSports**			
11	.01	Recessed AV wallbox and device conduit rough-in	X		
11	.02	Flat panel TV displays		X	
11	.03	Wall mount bracket		X	
11	.04	HDMI Matrix Switcher & Rack	X		
11	.05	HDMI & patch cables			X
12	**.00**	**Digital Signage - Monitors**			
12	.01	Recessed AV wallbox and device conduit rough-in	X		
12	.02	Flat panel displays		X	
12	.03	Wall mount bracket with tilt	X		
12	.04	Display PC or PC on a stick			X
12	.05	HDMI & patch cables			X
13	**.00**	**Fire alarm system (Silent Knight) (28 31 00)**			
13	.01	Device conduit rough-in	X		
13	.02	FA control Panel	X		
13	.03	FA Annunciator panel with LOC in main vestibule	X		
13	.04	FA Annunciator/Drill panel in Adminestration	X		
13	.05	Electrical connections	X		
13	.06	Detection and alarm devices	X		
13	.07	Low voltage cabling and terminations	X		
13	.08	Graphic display panel	X		
13	.09	AHJ review submittal documents	X		
13	.10	AHJ coordination and system testing & approval	X		
13	.11	Activation of connection to monitoring agency			X
13	.12	Testing, programming and training	X		

Pasco Orion High School - Pasco School District No. 1
Technology Component Systems Matrix

System ID	Component ID	System Description	Contractor Furnished Contractor Installed (CFCI)	Owner Furnished Contractor Installed (OFCI)	Owner Furnished Owner Installed (OFOI)
14	**.00**	**Lockdown**			
14	.01	Device conduit rough-in	**X**		
14	.02	Initiating devices; pushbuttons	**X**		
14	.03	Cabling, devices and terminations	**X**		
14	.04	Integration with intercom system	**X**		
14	.05	Integration with access control system	**X**		
14	.06	Connections to release doors, grilles & electronically controlled openings	**X**		
14	.07	Testing, programming and training	**X**		
			Dialtone	**Cellular**	**Network**
15	***.00***	**FA, Elevator & Security - Emergency Communication**			
15	.01	Fire Alarm Communication	**X**	**X**	**X**
15	.02	Elevator Emergency Commuication	**X**		**X**
15	.03	Security System Monitoring			**X**

DIVISION 31 – EARTHWORK

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Removing existing vegetation.
   2. Clearing and grubbing.
   3. Stripping and stockpiling topsoil.
   4. Removing above- and below-grade site improvements.
   5. Disconnecting, capping or sealing site utilities.
   6. Potholing of existing utilities.
   7. Temporary erosion- and sedimentation-control measures.

1.2 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

A. A pre-construction conference shall be scheduled with the contractor, engineer, architect, city personnel, and any affected utilities prior to the start of work.

B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

C. Utility Locator Service: Notify utility locator service for area where Project is located a minimum of 48 hours before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

E. The following practices are prohibited within protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation; or other digging: unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

1.4 REFERENCES

A. Adhere to the following Geotechnical Reports by GN Northern, Inc.: GNN Project No. 223-1666, dated July 2023, GNN Project No. 223-1666-1, dated September 2023.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving”.
   1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Prior to starting any field work on the project, Contractor shall complete and submit all necessary paperwork to transfer the operator of the Stormwater Permit from Knutzen Engineering to the Contractor for managing the permit for the duration of the project. Contractor shall be responsible for preparing and implementing a stormwater pollution prevention plan (SWPPP) in accordance with the Stormwater Management Manual For Eastern Washington (SWMMEW) and shall be responsible for monitoring stormwater, inspecting best management practice, providing a Certified Erosion And Sedimentation Control Lead (CESCL), stormwater sampling, monthly reporting, keeping records and terminating the permit upon completion.

B. The Owner will pay all Ecology Construction Stormwater General Permit fees from time of obtaining permit until project substantial completion. The Contractor shall request final inspection by Washington Department of Ecology (DOE) when project is complete and ensure that permit coverage is successfully terminated. If the Contractor fails to successfully terminate coverage of the project with DOE prior to substantial completion, any additional fees and/or penalties accrued after substantial completion will be the responsibility of the Contractor.

C. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion and sedimentation control Drawings and requirements of authorities having jurisdiction.

D. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

E. Inspect, maintain, and repair erosion and sedimentation control measures during construction until permanent vegetation has been established.

F. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

C. At utility connections and crossings, locate, pothole and identify existing utilities. Notify Engineer of findings.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
2. Use only hand methods for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.
B. Strip topsoil to depth indicated in a manner to prevent intermingling with underlying subsoil or other waste materials.
C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.6 SITE IMPROVEMENTS

A. Remove existing above and below grade improvements as indicated and necessary to facilitate new construction.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
B. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 31 10 00

SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
   2. Excavating and backfilling for buildings, structures, sidewalks and pavements.
   3. Drainage rock for infiltration trenches.
   4. Base course for concrete walks, pavements, and slabs-on-grade.
   5. Excavating and backfilling for utility trenches.

1.2 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.
B. Material Test Reports: For each borrow soil material proposed for fill and backfill as follows:
   1. Classification according to ASTM D 2487.
   2. Laboratory compaction curve according to ASTM D 1557.

1.3 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.
B. Base Course: Aggregate layer placed between the subgrade and hot-mix asphalt pavement or aggregate layer placed between the subgrade and a cement concrete pavement, slab, or a cement concrete or hot mix asphalt walk.
C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
E. Drainage Rock: Drainage material placed around perforated pipes located in infiltration trenches.
F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
   2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
G. Fill: Soil materials used to raise existing grades.
H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
I. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
J. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 REFERENCES

A. Adhere to the following Geotechnical Reports by GN Northern, Inc.: GNN Project No. 223-1666, dated July 2023, GNN Project No. 223-1666-1, dated September 2023.

1.5 QUALITY ASSURANCE

A. Pre-excavation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils:

1. The onsite native sandy soils are generally suitable for reuse as general fill, engineered fill, and utility trench backfill provided the materials are moisture conditioned for compaction and free of deleterious materials, roots, organic matter, debris, frozen soil and rock particles greater than 4 inches in diameter.
2. Imported crushed rock structural fill shall consist of well-graded, crushed aggregate material meeting the grading requirements of section 9-03.9(3) of the latest WSDOT Standard Specifications, i.e. 1-1/4" minus base course material.
3. Imported fill soils shall be non-expansive, granular soils meeting the USCS classifications of SM, SP-SM, or SW-SM with a maximum rock size of 4 inches, minimum 70% passing the No. 4 Sieve, and 5 to 15% passing the No. 200 Sieve (fines shall be non-plastic).

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Drainage Rock: Gravel backfill for drains per WSDOT Standard Section 9-03.12(4).

E. Trench Backfill:

1. Trench backfill placed beneath, adjacent to, and for at least 2 feet above utility lines (the pipe zone) shall consist of well-graded granular material with a maximum particle size of 1" and less than 10% by dry weight passing the US Standard No. 200 Sieve and shall meet the standards prescribed by WSDOT SS 9-03.12(3) - Gravel Backfill for Pipe Zone Bedding.
2. Trench backfill within pavement areas or beneath building pads shall consist of well-graded granular material with a maximum particle size of 1-1/2", less than 10% by dry weight passing the US Standard No. 200 Sieve and shall meet standards prescribed by WSDOT SS 9-03.19 - Bank Run Gravel for Trench Backfill.
3. Outside of structural improvement areas, trench backfill placed above the pipe zone shall consist of excavated material free of wood waste, debris, clods, or rocks greater than 6" in diameter and meet WSDOT SS 9-03.14 - Borrow and WSDOT SS 9-03.15 - Native Material for Trench Backfill.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in

a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course.

3.6 SUBGRADE INSPECTION

A. Proof-roll subgrade below the building slabs and pavements with a fully loaded tandem-axle pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28 day compressive strength of 2,500 psi, may be used when approved by Architect.
   1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.
B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete".
D. Trenches under Driving Surfaces: Provide 4 inch thick, concrete-base slab support for piping or conduit less than 24 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section "Cast-in-Place Concrete".
E. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
F. Place and compact final backfill of satisfactory soil to final subgrade elevation.
G. Install warning tape directly above utilities, 24 inches below finished grade, except 12 inches below subgrade under pavements and slabs.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 5 horizontal so fill material will bond with existing material.
B. Place and compact fill material in layers to required elevations.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. All structural fill and backfill shall be placed in maximum 8" lifts and compacted to at least 95% of the maximum dry density, in accordance with ASTM D1557, at an effective and workable

moisture content. The onsite soil will typically require moisture range of 2 to 3% above the optimum value.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

3.13 FOUNDATIONS

A. Shallow foundations shall be constructed to bear on a 12" compacted layer of imported 1-1/4" minus crushed rock structural fill (refer to earthwork notes for gradation requirements) placed atop the improved recompacted/engineered fill subgrade as described in the earthwork section. The crushed rock shall be compacted to at least 95% of the maximum dry density as determined by ASTM D1557 and shall extend 24 inches beyond all sides of the foundations.

B. Concrete floor slabs shall be supported on the prepared native silty sand, gravel or compacted structural fill placed on the native soils. A minimum 6” layer of 3/4" minus crushed aggregate fill shall be placed on an improved recompacted/engineered fill subgrade as described in the earthwork section. The crushed aggregate material shall meet section 9-03.9(3), "crushed surfacing top course", of the latest WSDOT Standard Specifications, and shall have less than 5 percent passing the No. 200 Sieve. The crushed rock material shall be compacted to at least 95% of the maximum dry density as determined by ASTM D1557.

3.14 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Turf or Unpaved Areas: Plus or minus 1 inch.
   2. Walks: Plus or minus 1 inch.
   3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10 foot straightedge.

3.15 BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place top course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place top course and base course under pavements and walks as follows:
   1. Shape base course to required crown elevations and cross-slope grades.
   2. Place base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
   3. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.16 BASE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact base course under cast-in-place concrete slabs-on-grade as follows:
   1. Place base course that exceeds 4 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 4 inches thick or less than 3 inches thick.
   2. Compact each layer of base course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

E. Special Inspection:
   1. Per IBC 1705.6, prior to placement of prepared fill, the special inspector shall determine that the site has been prepared in accordance with the approved geotechnical report.
   2. Per IBC 1705.6, where fill exceeds 12" in depth, the special inspector shall have continuous inspection of fill placement and compaction.
   3. Testing agency will test compaction of soils in place according to ASTM D 1557, ASTM D 2167, ASTM D 2937, ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:
      a. Foundation, paving, and adjacent: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 5,000 sq. ft. or less of paved area or building slab, but in no case fewer than 1 test per day.
      b. Trench backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length, but no less than 1 test per day.
   4. Compaction testing is required at the above schedule unless greater testing is recommended by structural drawings. Less testing would be acceptable if approved in writing by geotechnical engineer, special inspector, foundation engineer, and Knutzen engineering.

3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

DIVISION 32 – EXTERIOR IMPROVEMENTS

SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hot-mix asphalt paving.
   2. Pavement-marking paint.

B. Related Sections:
   1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
   2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
   1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
   2. Job-Mix Designs: For each job mix proposed for the Work.

B. Material Certificates: For each paving material, from manufacturer.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or WSDOT.

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the latest edition of Standard Specification M41-10 of WSDOT for asphalt paving work.
   1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

C. Preinstallation Conference: Conduct conference at Project site.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
   1. Tack Coat: Minimum surface temperature of 60 deg F.
   2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
   3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Aggregate shall be Class 1/2” modified with over 50% 3/8” aggregate and shall conform to the latest edition of WSDOT Standard Specification M41-10 Section 9-03.8(1), (2), (3)A and (3)B.

B. Blending sand shall conform to the latest edition of WSDOT Standard Specification 9-03.8(4).

2.2 ASPHALT MATERIALS

A. Asphalt material shall conform to the latest edition of WSDOT Standard Specification M41-10, Section 9-02.1(4) excluding elastic recovery requirements.

2.3 AUXILIARY MATERIALS

A. Herbicide: In conformance with the latest edition of WSDOT Standard Specification M41-10 Section 5-04.3(5)D. Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

B. Pavement-Marking Paint: Pavement markings shall be in accordance with WSDOT Standard Specifications M41-10, Section 8-22. Contractor shall use WSDOT approved materials, prepare the surfaces, apply the paint, and be within the tolerances as specified in the WSDOT Standard Specifications.

1. Color: As indicated.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Proof-roll subgrade below pavements with loaded tandem-axle pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

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

3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

3.3 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Spread mix at minimum temperature of 250 deg F.
2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.

4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations".

3.5 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
   1. Complete compaction before mix temperature cools to 185 deg F.
B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
   1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.6 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Base Course: Plus or minus 1/2 inch.
   2. Surface Course: Plus 1/4 inch, no minus.
B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10 foot straightedge applied transversely or longitudinally to paved areas:
   1. Base Course: 1/4 inch.
   2. Surface Course: 1/8 inch.
   3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.7 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
B. Allow paving to age for 30 days before starting pavement marking.
C. Sweep and clean surface to eliminate loose material and dust.
D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
B. Replace and compact hot-mix asphalt where core tests were taken.
C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.9 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 32 12 16

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY
- A. Section Includes:
  1. Driveways
  2. Curbs and gutters.
  3. Walks.

1.2 SUBMITTALS
- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.3 QUALITY ASSURANCE
- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.
- B. ACI Publications: Comply with ACI 301 unless otherwise indicated.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT
- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.
- C. Reinforcing Bars: ASTM A 615, Grade 60; deformed.
- D. Dowel Bars: ASTM A 615, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.
- E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.2 CONCRETE MATERIALS
- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
  1. Portland Cement: ASTM C 150, portland cement Type I/II.
- B. Normal-Weight Aggregates: ASTM C 33, Class 4M, uniformly graded. Provide aggregates from a single source.
- C. Water: Potable and complying with ASTM C 94.
- D. Air-Entraining Admixture: ASTM C 260.
- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

2.3 CURING MATERIALS
- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.4 RELATED MATERIALS
A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

2.5 CONCRETE MIXTURES
A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:
1. Compressive Strength (28 Days):
a. 4,000 psi for paving and curbs.
b. 3,500 psi for sidewalks and flatwork
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
3. Slump Limit: 5 inches plus or minus 1 inch.
4. Air Content: 5 1/2 percent plus or minus 1.5 percent.
B. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

2.6 CONCRETE MIXING
A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Furnish batch certificates for each batch discharged and used in the work.

PART 3 - EXECUTION

2.7 EXAMINATION AND PREPARATION
A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
B. Remove loose material from compacted subbase surface immediately before placing concrete.

2.8 EDGE FORMS AND SCREED CONSTRUCTION
A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

2.9 STEEL REINFORCEMENT
A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

2.10 JOINTS
A. General: Form construction, expansion, and dummy joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at expansion joints.
C. Expansion Joints: Form expansion joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, foundation walls, other fixed objects, and where indicated. Provide sealant at all expansion joints.

D. Dummy Joints: Form weakened-plane tooled dummy joints, sectioning concrete into areas as indicated. Construct dummy joints for a depth equal to at least one-fourth of the concrete thickness.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4 inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

2.11 CONCRETE PLACEMENT

A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.

B. Comply with ACI 301 requirements for measuring, mixing, transporting, placing, and consolidating concrete.

C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

D. Screed paving surface with a straightedge and strike off.

E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

2.12 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

2.13 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these.

2.14 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10 foot long, unleveled straightedge not to exceed 1/2 inch.
4. Joint Spacing: 3 inches.
5. Dummy Joint Depth: Plus 1/4 inch, no minus.
6. Joint Width: Plus 1/8 inch, no minus.

2.15 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY
- A. Section Includes:
  1. Cold-applied joint sealants.

1.2 PRECONSTRUCTION TESTING
- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, eight, Samples of materials that will contact or affect joint sealants. Use manufacturer's standard test method to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

1.3 SUBMITTALS
- A. Product Data: For each joint-sealant product indicated.
- B. Samples: For each kind and color of joint sealant required.
- C. Pavement-Joint-Sealant Schedule: Include the following information:
  1. Joint-sealant application, joint location, and designation.
  2. Joint-sealant manufacturer and product name.
  3. Joint-sealant formulation.
  4. Joint-sealant color.
- D. Product certificates.
- E. Product test reports.
- F. Preconstruction compatibility and adhesion test reports.

1.4 QUALITY ASSURANCE
- A. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021.
- B. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 MATERIALS
- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 COLD-APPLIED JOINT SEALANTS
- A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.
- B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.
- C. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.

2.3 JOINT-SEALANT BACKER MATERIALS
- A. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- B. Backer Strips for Cold -Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.4 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Cleaning of Joints: Clean out joints immediately before installing joint sealants.

C. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

D. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of joint-sealant backings.
   2. Do not stretch, twist, puncture, or tear joint-sealant backings.
   3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place joint sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
   1. Remove excess joint sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

G. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

H. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

END OF SECTION 32 13 73

SECTION 32 17 24 – ACRYLIC SURFACING

PART 1 - GENERAL

1.1 GENERAL DESCRIPTION
A. Textured acrylic surfacing for concrete pickleball and basketball courts
B. Striping for concrete pickleball and basketball courts

1.2 Related Sections include the following:
1. Division 12 Section "Site Furnishings" for pickleball equipment and basketball goals
2. See civil specifications for concrete paving

B. References

1. National Asphalt Paving Association (NAPA)
2. United States Tennis Association (USTA)
3. International Tennis Federation (ITF)
4. American Sport Builders Association (ASBA)

1.3 QUALITY ASSURANCE

A. Surfacing shall conform to the guidelines of the ASBA for planarity.

B. All surface coatings products shall be supplied by a single manufacturer.

A. The contractor shall record the batch number of each product used on the site and maintain it through the warranty period.

B. The contractor shall provide the inspector, upon request, with an estimate of the volume of each product to be used on the site.

E. The installer shall be an authorized applicator of the specified system.

F. The manufacturer's representative shall be available to help resolve material questions.

1.4 SUBMITTALS

A. Manufacturer specifications for components, color chart and installation instructions.

B. Authorized Applicator certificate from the surface system manufacturer.

C. ITF classification certificate for the system to be installed.

D. Reference list from the installer of at least 5 projects of similar scope done in each of the past 3 years.

E. Current Material Safety Data Sheets (MSDS).

F. Product substitution: If other than the product specified, the contractor shall submit at least 7 days prior to the bid date a complete type written list of proposed substitutions with sufficient data, drawings, samples and literature to demonstrate to the owners satisfaction that the proposed substitution is of equal quality and utility to that originally specified. Information must include a QUV test of at least 1000 hours illustrating the UV stability of the system. The color system shall have an ITF

pace rating in Category 3. Under no circumstances will systems from multiple manufacturers be considered.

1.4 MATERIAL HANDLING AND STORAGE

A. Store materials in accordance with manufacturer specifications and SDS.

B. Deliver product to the site in original unopened containers with proper labels attached.

C. All surfacing materials shall be non-flammable.

1.5 GUARANTEE

A. Provide a guarantee against defects in the materials and workmanship for a period of one year from the date of substantial completion.

1.6 INSTALLER QUALIFICATIONS

A. Installer shall be regularly engaged in construction and surfacing of acrylic tennis courts, play courts or similar surfaces.

B. Installer shall be an Authorized Applicator of the specified surface system.

C. Installer shall be a builder member of the ASBA.

1.7 MANUFACTURER QUALIFICATIONS

A. System manufacturer shall provide documentation that the surface to be installed has been classified by the ITF as a medium pace surface.

B. System manufacturer shall be a US owned company.

C. System manufacturer shall be a member of the ASBA.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. California Sports Surfaces, a division of the ICP Group, Andover, MA. 01810 / Plexipave System www.plexipave.com

B. Substitutions: Submit requests at least 7 days prior to the bid date with a complete type written list of proposed substitutions with sufficient data, drawings, samples and literature to demonstrate to the owners satisfaction that the proposed substitution is of equal quality and utility to the specified product. Information must include a QUV test of at least 1000 hours illustrating the UV stability of the system. The system shall have an ITF pace rating.

2.2 MATERIALS

A. Patching Mix (California Court Patch Binder) - for use in patching cracks, holes, depressions and other surface imperfections.

B. Crack Filler (California Crack Filler) - for use in filling fine cracks.

C. Acrylic Filler Course (California Acrylic Resurfacer) – for use as a filler for new concrete surfaces. The acrylic filler shall be blended with approved silica sand at the job site.

D. Acrylic Color Playing Surface (Plexichrome Ultra Performance/Plexipave Color Base) – for use as the finish color and texture. Plexichrome and Plexipave Color Base are blended at the job site to achieve the correct surface texture. *Factory Fortified Plexipave may be used as an alternative material. Colors to be chosen by owner from manufacturer's full color palette.

E. Line Paint (California Line Paint) – for use as the line marking on the court/play surface, white textured.

F. Water – for use in dilution/mixing shall be clean and potable.

G. All surfacing materials shall be non-flammable and have a VOC content of not less than 100g/L. Measured by EPA method 24.

H. Local sands are not acceptable in the color playing surface. Sands must be incorporated at the manufacturing location to ensure quality and stability.

PART 3 EXECUTION

3.1 WEATHER LIMITATIONS

A. Do not install when rainfall in imminent or extremely high humidity prevents drying.

B. Do not apply unless surface and air temperature are 50°F and rising.

C. Do not apply if surface temperature is in excess of 140°F.

3.2 PREPARATION FOR ACRYLIC COLOR PLAYING SYSTEM

A. Clean surfaces of loose dirt, oil, grease, leaves, and other debris in strict accordance with manufacturer's directions. Pressure washing will be necessary to adequately clean areas to be coated. Any areas previously showing algae growth shall be treated with Clorox or approved product to kill the organisms and then be properly rinsed.

B. Holes and cracks: Cracks and holes shall be cleaned and a suitable soil sterilant, as approved by the owner, shall be applied to kill all vegetation 14 days prior to use of **Court Patch Binder** according to manufacturer's specifications.

C. Depression: Depressions holding enough water to cover a US five-cent piece shall be filled with Court Patch Binder Patching Mix. 3 gallons of Court Patch Binder, 100 lbs. 60-80 silica sand, 1-gallon Dry Portland Cement (Type I). **This step shall be accomplished prior to the squeegee application of Acrylic Resurfacer.** The contractor shall flood all the courts and then allow draining. Define and mark all areas holding enough water to cover a nickel. After defined areas are dry, prime with tack coat mixture of 2 parts water/l part Court Patch Binder. Allow tack coat to dry com-

pletely. Spread Court Patch Binder mix true to grade using a straight edge (never a squeegee) for strike off. Steel trowel or wood float the patch so that the texture matches the surrounding area. Never add water to mix. Light misting on surface and edges to feather in is allowed as needed to maintain work ability. Allow to dry thoroughly and cure.

NO WORK FROM THIS STAGE ON SHALL COMMENCE UNTIL AN INSPECTOR HAS ACCEPTED THE SURFACE.

D. On new concrete, two coats of Acrylic Resurfacer shall be used to properly fill all voids in the concrete surface. Use clean, dry 50-60 mesh sand and clean, potable water to make mixes. The quantity of sand and water in the above mix may be adjusted within above limits to complement the roughness and temperature of the surface.
   1. Mix the ingredients thoroughly using accepted mixing devices and use a 70 Durometer rubber bladed squeegee to apply each coat of Acrylic Resurfacer as required.

   2. Allow the application of Acrylic Resurfacer to dry thoroughly. Scrape off all ridges and rough spots prior to any subsequent application of Acrylic Resurfacer or subsequent cushion or color surface system.

3.3 APPLICATION OF ACRYLIC COLOR PLAYING SURFACE

A. All areas to be color coated shall be clean, free from sand, clay, grease, dust, salt or other foreign matters. The Contractor shall obtain the Engineer's approval, prior to applying any surface treatment.

B. Blend color base and Plexichrome Ultra Performance with a mechanical mixer to achieve a uniform Fortified Plexipave mixture. The mix shall be:

Color Base	30 gallons
Plexichrome	20 gallons
Water	20 gallons

C. Application shall be made by 50 durometer rubber faced squeegees. The Fortified Plexipave mixture should be poured on to the court surface and spread to a uniform thickness in a regular pattern.

D. A total of 3 applications of Fortified Plexipave shall be made to achieve a total application rate of not less than .15 gal./sy. No application should be made until the previous application is thoroughly dry.

3.4 LINE PAINTING

A. Line shall be 2” wide unless otherwise noted on the drawings. Lines hall be carefully laid out in accordance with ASBA and USTA guidelines. The area to be marked shall be taped to insure a crisp line. The California Line Paint shall have a texture similar to the surrounding play surface. Application shall be made by brush or roller at the rate of 150-200 sg./gal. (3/4 gal. per tennis court).

3.5 PROTECTION

A. Erect temporary barriers to protect coatings during drying and curing.

B. Lock gates to prevent use until acceptance by the owner’s representative.

3.6 CLEAN UP

A. Remove all containers, surplus materials and debris. Dispose of materials in accordance with local, state and Federal regulations.

B. Leave site in a clean and orderly condition.

.

END OF SECTION

SECTION 32 18 13 – SYNTHETIC TURF

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the delegated design for bid alternate 8- synthetic turf, including:
   1. Synthetic turf products and base materials
   2. Paint striping for volleyball court and sleeve installation - part of bid alternate 8

B. Related Sections include the following:
   1. Division 12 Section "Site Furnishings" for removeable volleyball posts and net.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Delegated Design Submittal:
   1. Shop Drawings: for Synthetic turf surfacing, volleyball court striping, and sleeves
      a. Include sections and details for turf installation
      b. Show installation method at interfaces of turf and concrete paving, and turf and concrete curbs
      c. Show locations of seams and method of seaming
      d. Show layout of Volleyball court striping lines. Indicate application method of lines.
      e. Show layout for Volleyball post sleeves. Include detail for installation method.

C. Samples:
   1. Turf Fabric- 12” square
   2. Infill Material- 1 quart volume of material, of each type to be used
   3. Seam Sample- 24” square with seam centered in sample

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data for installer
B. Product test reports: for each synthetic grass surfacing assembly
C. Field quality-control reports
D. Sample warranties: for special warranties

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data: For synthetic grass surfacing, including maintenance cleaning instructions, to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Turf Fabric- minimum 300 square feet
   2. Infill Material- Minimum of two bags of each type used
   3. Seaming Tape and Adhesive- One roll of seaming tape and one gallon of adhesive.
   4. One new set of maintenance tools, of type recommended by synthetic grass surfacing manufacturer for installation.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials in location and manner to allow installation of synthetic turf surfacing without excess disturbance of granular base.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated design: design details for synthetic turf installation, volleyball court striping, and volleyball post sleeve installation per manufacturer's instructions.

B. Contractor shall ensure that products for the synthetic turf system meet the following performance requirements:
   1. All components and their installation method shall be designed and manufactured for landscape use. The materials as hereinafter specified shall withstand full climatic exposure in the location of the installation, be resistant to insect infestation, rot, fungus, mold and mildew, shall also withstand ultra-violet rays and extreme heat, and allow the free flow of water vertically through the surface and into the drainage system below the surface.
   2. The seams of all system components shall provide a permanent, tight, secure, and hazard free surface.
   3. The installed synthetic grass and drainage system shall allow for drainage and water flow through the system at a rate of not less than 20 inches per hour.
   4. Based on independent laboratory tests, the synthetic turf product must be shown to meet or exceed ASTM testing standards F1551, D1335, F1015, D5034, F2898, & F2765.

2.2 SYNTHETIC GRASS SURFACING

A. Synthetic Grass Surfacing: Complete surfacing system, consisting of synthetic yarns bound to water-permeable backing and infill indicated, suitable for multipurpose turf fields.
   1. ForeverLawn Fusion Pro. Contact: Ben Stanford bens@rossrec.com, 707-538-3800
   2. Or Approved Equal

B. Turf Fabric: Woven turf fabric with multicolored fiber and UV resistance, complying with the following:
   1. Face Yarn Type: Primary: Nylon monofilament; Secondary: Textured nylon monofilament
   2. Construction: Dual yarn, same row
   3. Backing: Manufacturer's standard woven or nonwoven polypropylene primary backing with urethane-coated secondary backing; provide perforations or drainage channels sufficient to meet permeability indicated.
   4. Seaming: Micromechanical bonding
   5. Color: Primary and secondary colors must differ. Primary colors to consist of medium green shades with secondary colors consisting of dark green and tan shades.
   6. Yarn Count: Primary: 8800/8; Secondary: 4950/9
   7. Tufting Gauge: 3/8 in.
   8. Pile Height (tufted): 1 3/8" (finished height may be slightly lower)
   9. Pile Weight: 45 oz. /sq. yd.
   10. Total Product Weight: 100 oz./ sq. yd.

C. Seams
   1. All seams shall be installed and secured with micromechanical bonding. Seams secured with adhesive or stitching alone shall not be acceptable.

D. Infill

1. Infill material is recommended for best performance. Recommended infill amount is three pounds of 12-20 mesh coated sand per sq. ft.
2. Infill Proportions: Manufacturer's standard proportions

2.3 SPORT MARKING PAINT

A. Game Lines and Markings: Provide Volleyball court lines and markers in widths and colors (white) according to requirements indicated on Drawings using the following:

1. Stripe-X Synthetic Turf Paint. Removeable, water-based paint for synthetic turf, white.
2. Or Approved Equal.

3.4 VOLLEYBALL POST SLEEVES

A. Location as shown on plans. Install post sleeves VB21 By Bison 800-247-7668 www.bisoninc.com.
1. Embed mount sleeves per manufacturer specifications.

PART 3 – EXECUTION

2.4 EXAMINATION

A. Examine base and other conditions, with Installer present, for compliance with requirements for installation tolerances, permeability, and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

2.5 INSTALLATION

A. Install base, turf, and infill per synthetic turf manufacturer’s instruction.

B. Adhere to Manufacturer’s instructions for base and drainage contruction.

C. Contractor shall adhere to manufacturer’s instructions for clean-up during and after installation.

D. Install sleeves per manufacturer’s instruction.

2.6 FIELD QUALITY CONTROL

A. The synthetic grass vendor must verify that a qualified representative has inspected the installation and that the finished synthetic surface conforms to the manufacturer’s requirements.

B. Extra materials: Owner shall be given the option to retain and store excess materials such as turf and infill ordered for project, but not installed.

2.7 DEMONSTRATION

A. Train Owner's maintenance personnel in proper maintenance procedures for synthetic grass surfacing.

END OF SECTION 32 18 13

SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Chain-Link Fences: Industrial.
2. Gates: Single and Double Swing.

B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for concrete.
2. Division 31 Section "Earth Moving" for site excavation, fill, and backfill where chain-link fences and gates are located.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide chain-link fences and gates capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Minimum Post Size and Maximum Spacing for Wind Velocity Pressure: Determine based on mesh size and pattern specified, and on the following minimum design wind pressures and according to CLFMI WLG 2445:

a. Wind Speed: 80 mph.
b. Fence Height: 3 feet and 6 feet- see drawings for locations
c. Line Post Group: Schedule 40 steel pipe.
d. Wind Exposure Category: B.

2. Determine minimum post size, group, and section according to ASTM F 1043 for framework up to 6 feet high, and post spacing not to exceed 10 feet.

1.4 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.

1. Fence and gate posts, rails, and fittings.

2. Chain-link fabric, reinforcements, and attachments.
3. Gates and hardware.

B. Shop Drawings: Show locations of fences, gates, posts, rails, tension wires, details of extended posts, gate swing, or other operation, hardware, and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components. Include plans, gate elevations, sections, details of post anchorage, attachment, bracing, and other required installation and operational clearances.
1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Repair of existing fencing, including top rail replacement, wire, top caps and tension wires.

C. Samples for Verification: For each type of chain-link fence and gate indicated.

1. Steel wire (for fabric) in 6-inch lengths.

D. Product Certificates: For each type of chain-link fence and gate, signed by product manufacturer.

1. Strength test results for framing according to ASTM F 1043.

E. Qualification Data: For Installer.

F. Field quality-control test reports.

G. Maintenance Data: For the following to include in maintenance manuals:

1. Polymer finishes.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed chain-link fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

1. Engineering Responsibility: Preparation of data for chain-link fences and gates, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified according to NETA ETT, or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

B. Interruption of Existing Utility Service: Do not interrupt utility services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of utility services.
2. Do not proceed with interruption of utility services without Architect's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Pacific Fence and Wire Co.

2. Merchant Metals

3. Master Halco

4. Approved Equal

2.2 CHAIN-LINK FENCE FABRIC

A. General: Height indicated on Drawings. Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with ASTM A 392, CLFMI CLF 2445, and requirements indicated below:

1. Steel Wire Fabric: Galvanized wire with a diameter of 0.192 inch. 6 foot height.

a. Mesh Size: 2 inches.

b. Vinyl Coated: Fencing fabric and accessories shall be class 2A black vinyl coated in accordance with ASTM F668 as noted in the drawings.

2. Steel Wire Fabric: Galvanized wire with a diameter of 0.192 inch. 3 foot height.

a. Mesh Size: 2 inches.

b. Vinyl Coated: Fencing fabric and accessories shall be class 2A black vinyl coated in accordance with ASTM F668 as noted in the drawings.

3. Selvage: Knuckled at both selvages.

2.3 INDUSTRIAL FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, ASTM F 1083 for Group IC round pipe, and the following:

1. Group: IB, aluminum pipe, Alloy 6063.
2. Fence Height: 3 feet and 6 feet.
3. Strength Requirement: Light industrial according to ASTM F 1043.
4. Post Diameter and Thickness: According to ASTM F 1043.
5. Post Size and Thickness: According to ASTM F 1043.

a. Top Rail: 1.66 inches.
b. Line Post: 2.375 inches.
c. End, Corner and Pull Post: 2.875 inches.
d. Swing Gate Post: According to ASTM F 900.

6. Coating for Steel Framing:

a. Powder coated, black

2.4 TENSION WIRE

A. General: Provide horizontal tension wire at the following locations:

1. Location: Extended along top and bottom of fence fabric.
2. Location: As indicated.

B. Metallic-Coated Steel Wire: 0.177-inch- diameter, marcelled tension wire complying with ASTM A 817, ASTM A 824, and the following:

1. Metallic Coating: Type I, aluminum coated (aluminized) by hot-dip process, with the following minimum coating weight:

a. Class 1: Not less than 0.8 oz./sq. ft. of uncoated wire surface.
b. Class 2: Not less than 1.2 oz./sq. ft. of uncoated wire surface.
c. Class 3: Not less than 2 oz./sq. ft. of uncoated wire surface.
d. Matching chain-link fabric coating weight.

2. Metallic Coating: Type III, Zn-5-Al-MM alloy with the following minimum coating weight:

    a. Class 1: Not less than 0.6 oz./sq. ft. of uncoated wire surface.
    b. Class 2: Not less than 1 oz./sq. ft. of uncoated wire surface.
    c. Matching chain-link fabric coating weight.

C. Aluminum Wire: 0.192-inch- diameter tension wire, mill finished, complying with ASTM B 211 Alloy 6061-T94 with 50,000-psi minimum tensile strength.

2.5 INDUSTRIAL SWING GATES

A. General: Comply with ASTM F 900 for single and double swing gate types.

1. Metal Pipe and Tubing: Galvanized steel, powder coated black. Comply with ASTM F 1043 and ASTM F 1083 for materials and protective coatings.
2. Metal Pipe and Tubing: Aluminum, powder coated black. Comply with ASTM B 429 and ASTM F 1043 for materials and protective coatings.

B. Frames and Bracing: Fabricate members from round, aluminum tubing with outside dimension and weight according to ASTM F 900 and the following:

1. Gate Fabric Height: 2 inches less than adjacent fence height as indicated.
2. Leaf Width: As indicated in drawings.
3. Frame Members:

    a. Tubular Aluminum: 1.66 inches round.

C. Frame Corner Construction:

1. Welded or assembled with corner fittings and 5/16-inch- diameter, adjustable truss rods for panels 5 feet wide or wider.

D. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

1. Padlocks and chains if not Owner furnished.

2.6 FITTINGS

A. General: Comply with ASTM F 626.

B. Post and Line Caps: Provide for each post.

1. Line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: Attach rails securely to each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Aluminum Alloy 6063 not less than 6 inches long.
2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails in the fence line-to-line posts.

E. Tension and Brace Bands: Aluminum Alloy 6063.

F. Tension Bars: Aluminum, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:

a. Hot-Dip Galvanized Steel: 0.106-inch- diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.
b. Aluminum: ASTM B 211; Alloy 1350-H19; 0.148-inch diameter, mill-finished wire.
c. Powder coated, black.

2.7 CAST-IN-PLACE CONCRETE

A. Materials: Portland cement complying with ASTM C 150, Type I aggregates complying with ASTM C 33, and potable water for ready-mixed concrete complying with ASTM C 94/C 94M.

1. Concrete Mixes: Normal-weight concrete air entrained with not less than 3000-psi compressive strength (28 days), 3-inch slump, and 1-inch maximum size aggregate.

B. Materials: Dry-packaged concrete mix complying with ASTM C 387 for normal-weight concrete mixed with potable water according to manufacturer's written instructions.

2.8 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance.

1. Do not begin installation before final grading is completed, unless otherwise permitted by Architect.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

3.4 CHAIN-LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
b. Concealed Concrete: Top 2 inches below grade to allow covering with surface material.
c. Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

d. Posts Set into Voids in Concrete: Form or core drill holes not less than 5 inches deep and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

D. Line Posts: Space line posts uniformly at 8 feet o.c.

E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 6 feet or higher, on fences with top rail and at 2/3 fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric.

1. Top Tension Wire: Install tension wire through post cap loops.
2. Bottom Tension Wire: Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

H. Bottom Rails: Install, spanning between posts.

I. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1 inch between finish grade or surface and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.

K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at 1 end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

L. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.5 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary. See drawings for gate widths.

3.6 FIELD QUALITY CONTROL

A. Quality control:

3.7 ADJUSTING

A. Gate: Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

END OF SECTION 323113

SECTION 32 31 19 - DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Decorative fence panels
   2. Security swing gates

B. Related Requirements:

   1. Section 033053 "Miscellaneous Cast-in-Place Concrete" for concrete post concrete fill.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fencing and gates.

   1. Include elevations, sections, gate locations, post spacing, and details.

C. Samples: For each fence material and for each color specified.

   1. Provide Samples 12 inches length for linear materials.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For gate operators to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

1.7 PRODUCT HANDLING AND STORAGE

A. Upon receipt at the job site, all materials shall be checked to ensure that no damages occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism, and theft.

1.8 PRODUCT WARRANTY

A. See manufacturer's standard warranty

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind Loading:

1. Fence Height: 7'
2. Wind Exposure Category: B
3. Design Wind Speed: 110 mph

2.2 DECORATIVE STEEL FENCES

A. Decorative Steel Fences:

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

a. Ameristar Montage II Genesis 3-rail, standard bottom.

B. Posts: 3" Square x 12ga

C. Post Caps: Ameristar Montage II standard flat cap

D. Rails: Montage II 1-3/4" by 1-3/4" x 12ga

E. Pickets: 1" square x 14 ga
1. Picket Spacing: 4 inches clear, maximum.

F. Brackets: Ameristar "Industrial Flat Mount Bracket"

G. Fabrication: Assemble fences into sections by welding or fastening pickets to rails.

1. Fabricate sections with clips welded to rails for field fastening to posts.
2. Drill clips for fasteners before finishing.

H. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

I. Finish: Powder coated black

2.3 SWING GATES

A. Ameristar “Exodus Single Egress Gate”, 42” wide
   1. Gate(s) Configuration: Single swing
   2. Gate(s) Frame Height: 84 inches.
   3. Gate(s) Opening Width: 42 inches
   4. Picket Size, Configuration, and Spacing: 1” picket, 3.25” standard spacing.
   5. Infill: Expanded metal mesh shall be ¾” x #9 flattened
   6. Hardware:
      a. Preinstalled panic exit device hardware set (included)
      b. Hinges shall be stainless steel five knuckle bearing hinges with non-removable pin and stainless-steel fasteners.
   7. Steel Finish: Powder coated, black
   8. Installation type: Direct bury, with removeable threshold

2.4 COATING MATERIALS

A. Shop Primers for Steel: Provide primers that comply with Section 099600 "High-Performance Coatings."

B. Shop Primer for Steel: Manufacturer's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

C. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.

D. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M and specifically recommended by manufacturer for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

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

3.2 PREPARATION

A. Stake locations of gate posts. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

1. Construction layout and field engineering are specified in Section 017300 "Execution."

3.3 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.4 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

END OF SECTION 323119

SECTION 32 84 00 - PLANTING IRRIGATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. PVC Mainline.
2. Piping.
3. Automatic control valves.
4. Drain valves.
5. Transition fittings.
6. Miscellaneous piping specialties.
7. Isolation valves.
8. Sprinklers.
9. Quick couplers.
10. Controllers.
11. Control wiring.
12. Boxes for automatic control valves.
13. Joint Restraints

1.3 DEFINITIONS

A. Circuit Piping: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.

B. Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.

C. ET Controllers: Evapotranspiration Controllers. Irrigation controllers which use some method of weather-based adjustment of irrigation. These adjusting methods include use of historical monthly averages of ET; broadcasting of ET measurements; or use of on-site sensors to track ET.

D. Main Piping: Downstream from the point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 PERFORMANCE REQUIREMENTS

A. Irrigation zone control shall be automatic operation with controller and automatic control valves.

B. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage of areas indicated.

C. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:

1. Irrigation Main Piping: 165 psig
2. Circuit Piping: 150 psig

1.5 ACTION SUBMITTALS

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

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Name and address of a permanent service organization(s) maintained or trained by the manufacturer(s) that will render satisfactory services within eight hours of receipt of notification that service is requested.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sprinklers, controllers and automatic control valves to include in operation and maintenance manuals.

B. Electronic As-Built Record Drawings: Maintain a complete set of as-built drawings which shall be corrected daily to show changes in location of all pipe, valves and related irrigation equipment. Valves shall be shown with dimensions to reference points. Drawings shall be in a (PDF format).

C. Controller Chart: Prepare a map diagram showing location of all new valves, lateral lines, and route of the control wires. Identify all valves as to size, station, number, and type of irrigation. “As-built” drawings must be approved before charts are prepared.
1. Provide one controller chart showing the area covered by controller for each automatic control valve supplied at the maximum size controller door will allow. chart shall be reduced drawing of the actual “As-built” system. If controller sequence is not legible when the drawing is reduced, the drawing shall be enlarged to a size that is reasonable.
2. Chart shall be a blackline print with different color used to show area of coverage for each station. When completed and approved, chart shall be hermetically sealed between two pieces of plastic, each piece being a minimum of 20 mils

thick. Charts must be completed and approved prior to final inspection of the irrigation system.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers that include a certified irrigation designer qualified by The Irrigation Association.

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

1.9 DELIVERY, STORAGE, AND HANDLING

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

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

1.10 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

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

B. Should uncharted piping or other utilities be encountered during excavation, consult the utility owner immediately for directions. Cooperate with the owner and public companies in keeping their respective services and facilities in operation. Repair damaged utilities to the satisfaction of the utility owner. The cost of repairing charted utilities shall be paid by the Contractor at no additional cost to the Owner.

C. Protect buildings, equipment, utilities, sidewalks, paving, reference points, monuments, and markers on the site. Take extreme caution when trenching at adjacent to aggregate base courses, and around existing trees and their root systems. No root cutting is allowed without prior approval. Protect adjacent properties. Protect work by others. Replace or repair damaged items at no cost to the Owner and to the approval of the Owner’s Representative.

1.11 WARRANTY

A. Warranty work and materials in writing for two years from the date of final acceptance, against defective workmanship and materials. All failures in workmanship or materials will be repaired at no additional cost to the Owner immediately after notification by the Owner's Representative.

B. The contractor shall be responsible for maintaining the system and protecting it from all damage until date of Final Acceptance at no additional cost to Owner. This shall include damage caused by vandalism or adverse weather conditions.

1.12 ONE-YEAR CORRECTION PERIOD

A. Repair any settling of backfilled trenches occurring during the one-year correction period at no additional cost to Owner. Include complete restoration of all damaged planting, pavement, and or other improvements of any kind.

1.13 SYSTEM COVERAGE

A. The system is designed to provide full coverage, less plant interference, on all planting areas. It is anticipated that Contractor will exercise professional judgment in location, height, slope of sprinkler heads without measurably changing the system design. No changes shall be made to the system design without the prior approval of Owner's Representative.

1.14 SYSTEM FAMILIARIZATION

A. Upon acceptance of the system by Owner's Representative, Contractor shall provide the necessary keys and other tools necessary to operate, drain, and activate the system. Contractor shall train Owner's maintenance personnel and provide written instructions to ensure that the system operation, maintenance, and winterizing can continue after departure of the Contractor. Contractor will be liable for all damages or losses resulting from failure to comply with the provisions of this Article.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

B. PVC Mainline Pipe: ASTM D-1785, Schedule 40 PVC.

C. PVC Mainline Pipe For Future Use: ASTM D-1784, C900 DR 18 PVC

D. PVC Lateral line Pipe, Pressure Rated: ASTM D-241, Class 200, SDR 21, 200 psi minimum..

E. Nipples, Fittings, Pipe Restraints:

1. Self-Restraining Ductile Iron Fittings, Leemco, Inc. Deep, slant bell ductile iron Fittings. Bends, Tee, Bell x Bell Reducer, Plug and tapped plug cap, Tapped cap and side outlet cap, service tees, and Bell x MPT adapters.

2. FPT & Lateral SS Range Saddles, RSST and RSDT Series. Leemco, Inc. FPT Stainless steel strap saddles for plastic pipe.

3. Steel Pipe: Malleable iron, ANSI B16.3.

4. PVC Socket Fittings, Schedule 40: ASTM D-2466; and Schedule 80: ASTM D 2467.

5. PVC Pipe Nipples: ASTM D-1785, PVC 1120 compound, Schedule 80.

6. PVC Threaded Fittings, Schedule 80: ASTM D-2464.

7. Flexible PVC Swing Joints: 'Funny Pipe' and equivalent not allowed.

8. Air Compressor Fitting: Dixon Air King RAM7 Stainless Steel 316 Air Hose Fitting, 2 Lug Universal Coupling, 1" NPT male fitting. Provide to owner after winterization.

F. Sleeves: PVC pipe under all paving, sized to accommodate required sizes and numbers of pipes and wires, 6-inch minimum diameter, in no case less than twice the diameter of the pipe being sleeved.

1. SDR 21 PVC Class 200 plastic pipe. Size as indicated on the drawings.

2.2 BOOSTER PUMP

1. Booster Pump: Munro Model: SIMP23053PHBP

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick unless otherwise indicated; 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. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

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

E. Pipe Solvent Cement:

1. PVC Solvent Cement ASTM D-2564.

2. I.P.S. 705 for pipe sizes up to 2 inch diameter.

3. I.P.S. 711 cement with P70 primer for pipe sizes 2-1/2 inches and larger.

F. PVC Primer:

1. ASTM F-656, I.P.S. P-70.

G. PVC Cleaner:

1. SCAQMD 1168, Low V.O.C, I.P.S. C-65

H. Field assembled Swing Joints:

1. For Rotors and Quick Couplers: Schedule 40 PVC fittings and Schedule 80 PVC nipples as shown on the drawings. Size to match inlet size of rotor head or quick coupler. Use is acceptable for all flows.

I. Swing Joint Assemblies:

1. Class 315 PVC construction with leak-proof “O-ring” seals. Size to match inlet size of pop-up rotor head or quick coupler. Use for flows greater than 4 gpm. Length as required. Lasco triple swing joint or equal.
2. Flexible PE swing pipe flexible riser assembly: Minimum 18-inch length polyethylene piping with black Marlex spiral barb fittings. Use for flows under 4 gpm. RainBird swing assemblies or equal.

2.4 ISOLATION VALVE

A. Isolation Valves for Mainline. Landscape Products Brass Ball Valves. Same size as mainline.

2.5 QUICK COUPLING VALVE

A. Quick Coupling Valves: Rain Bird 44-LRC 1 inch with corresponding key and swing joint.

2.6 DRAIN VALVE

A. Drain Valve: Nibco, T-311-Y bronze, angle valve, threaded.

2.7 AUTOMATIC CONTROL VALVES

A. Plastic, Automatic Control Valves:

1. As indicated on the Drawings.

2. Description: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid.

2.8 MASTER VALVE/FLOW SENSOR WITH WATER METER

A. Master valve/flow sensor with water meter: Netafim Hydrometer, photo diode register 2".

2.9 DRIP

A. Emitters: Rain Bird, XB-PC as indicated on the drawings

B. Distribution Tubing: Rain Bird XT-700 and Rain Bird XQ

C. Fittings: Compression fittings as indicated on the drawings

D. Drip Control Valves: As indicated on the drawings

2.10 SPRINKLERS

A. General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure.

B. Plastic, Pop-up Spray Sprinklers:

1. As scheduled on the Drawings.
2. Description:

a. Body Material: ABS.
b. Nozzle: ABS.
c. Retraction Spring: Stainless steel.
d. Internal Parts: Corrosion resistant.
e. Pattern: Fixed, with flow adjustment.

C. Plastic, Rotor Sprinklers:

1. As scheduled on the Drawings.

D. Plastic, Deep Root Watering System:

1. As scheduled on the Drawings.

2.11 AUTOMATIC CONTROL SYSTEM

A. Controller: Toro DXi-PWM-TW, DXi AC decoder, painted steel wall mount with UHF radio.

B. Description:

1. Controller Stations for Automatic Control Valves: Each station is variable from approximately 5 to 60 minutes. Include switch for manual or automatic operation of each station.

2. Interior Control Enclosures: Toro 2-wire wall mounted controller box for DXi controller, with locking cover and two matching keys.

    a. Body Material: Painted steel.
    b. Mounting: Surface type for wall.

3. Control Transformer: 24-V secondary, with primary fuse.
4. Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily.

    a. Manual or Semiautomatic Operation: Allows this mode without disturbing preset automatic operation.
    b. Surge Protection: Metal-oxide-varistor type on each station and primary power.

5. Communication: Ethernet

C. Electrical Control Wire and Accessories:

1. Low-Voltage, Decoder-Circuit cables: No. 14 AWG minimum, between controller and automatic control valves up to 1000', No. 12 AWG from 1000' up; purple jacketed.
2. Electrical Conduit and Fittings: High-impact Schedule 40 PVC C-2000 compound, UL approved, gray color, size as required. Solvent-weld fittings.
3. Splicing Materials: 14-gauge water-tight connectors per manufacturers recommendations for Eagle Plus 2-Wire controller..
4. Decoders: per manufacturers recommendations for DXi 2-Wire Controller.
5. Lightning arrestor: per manufacturers recommendations, every 600 feet

2.12 BOXES FOR VALVES

A. Valve Boxes and Vaults: HDPE plastic boxes. 'Carson Brooks', 'Armor' or equal, with locking top and 6-inch extensions to facilitate required depth of installation where applicable. Lids shall be purple (Non Potable) color unless otherwise noted.

1. Electric valves shall be installed in Jumbo boxes.
2. Quick couplers shall be installed in standard valve boxes.
3. Ball valves shall be installed in jumbo valve boxes.
4. Drain Valves shall be in adjustable valve box as shown on plans.
5. Flow sensor shall be installed in jumbo valve box.
6. Pull boxes and splice boxes shall be standard boxes with black covers.

B. Valve Box and Vault Accessories

1. Drain Rock: 3/4 inch to l/4 inch clean and washed pea gravel, no fines.
2. Filter Fabric: Woven or non-woven geotextile for use in separating drain rock from subgrade in valve box and vault installations while providing adequate drainage.
3. Brick or Concrete Block Supports: (2)-4-inch by 8-inch by 4-inch bricks or (1) 8-inch by 8-inch by 4-inch concrete paver at each corner of valve box.

2.13 OTHER MATERIAL

A. Detectable Warning Tape: Minimum 3-inch wide, 5 mils thick inert plastic tape with continuous layer of aluminum foil encased in the plastic. Tape identification shall match the utility being marked on all mainline. 'Terra Tape' Detectable, or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to all work of this section, carefully examine the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.

B. Verify that irrigation system may be installed in strict accordance with all pertinent codes and regulations, the original design, the referenced standards, and the manufacturer's recommendations.

C. In the event of discrepancy, immediately notify the Owner's Representative. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved. Start of work denotes acceptance.

D. Install materials and equipment in strict accordance with manufacturer's written specifications and recommendations and all applicable codes.

E. Provide protection at all times to keep rock, dirt, gravel, debris, and all other foreign materials from entering piping, valves, and other irrigation equipment.

3.2 EARTHWORK

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

B. Install warning tape directly above pressure piping, 12 inches below finished grades, except 6 inches below subgrade under pavement and slabs.

C. Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone, graded from 3/4 to 3 inches, to 12 inches below grade. Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.

D. Provide minimum cover over top of underground piping according to the following:

1. Irrigation Main Piping: Minimum depth of 24 inches below finished grade.
2. Circuit Piping: 18 inches except when over separation fabric.
3. Drain Piping: 18 inches.
4. Sleeves: 24 inches.

3.3 PREPARATION

A. Set stakes to identify locations of proposed irrigation system. Obtain Architect's approval before excavation.

3.4 PIPING INSTALLATION

A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.

B. Install piping at minimum uniform slope of 0.5 percent down toward drain valves.

C. Install piping free of sags and bends.

D. Install groups of pipes parallel to each other, spaced to permit valve servicing.

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

F. Install expansion loops in control-valve boxes for plastic piping.

G. Lay piping on solid subbase, uniformly sloped without humps or depressions.

H. Install PVC piping in dry weather when temperature is above 40 deg F. Allow joints to cure at least 24 hours at temperatures above 40 deg F before testing.

I. Install piping in sleeves under parking lots, roadways, and sidewalks.

J. Install sleeves made of Class 200 PVC pipe and socket fittings, and solvent-cemented joints.

K. Mainline trench spoils shall be used for trench backfill.

L. Lateral line piping shall be placed on top of the marker geotextile after installation at a depth of 12”. All other lateral line piping shall be placed with 18” cover depth.

3.5 JOINT CONSTRUCTION

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

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

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

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

D. Self Restrained Joints: Install per manufacturer's specifications.

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

F. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Pressure Piping: Join schedule number, ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
3. PVC Nonpressure Piping: Join according to ASTM D2855.

3.6 IRRIGATION SLEEVES

A. Install piping and wiring in sleeves under sidewalks, roadways, parking lots, and railroads.

1. Install piping sleeves by boring or jacking under existing paving if possible.

B. Install separate sleeves for irrigation lines and control wires under pavement prior to placing pavement materials wherever possible.

C. Extend sleeves beyond pavement edge a minimum of 12 inches. Install sleeves with minimum 24 inches depth of cover to the top of the pipe.

D. If length of required sleeve is greater than the length of the unit of pipe, solvent weld joints. Otherwise all sleeves shall be of one continuous length of pipe.

E. Tape ends of sleeve closed to keep soil out of the sleeve until irrigation lines and control wire are installed.

F. Permanently attach a single length of 14 gauge trace wire above the entire length of the sleeve.

G. Stake both ends of sleeves with a readily visible stake extending 12 inches above-grade and below-grade to the bottom of the sleeve. Mark the above-grade portion of the stake with the words "Irrig. Sleeve". Remove stakes after sleeves are recorded on

As-Built Drawings and after irrigation lines and control wires are installed and accepted by Owner’s Representative.

3.7 CONTROL WIRING

A. Install per manufacturer’s instructions with minimum 24 inch expansion loop at each controller.

B. All wire splicing to be made waterproof by using U.L. approved wire connectors and sealant. Follow manufacturer's instructions for installation.

C. All wire splicing shall occur only at the valve or at the controller.

D. Single-strand copper, UL approved for direct burial, AWG-UF type, sized per manufacturer's recommendations, No. 14-gauge minimum.

E. Use red/black 14 gauge wire per manufacturer’s recommendations.

F. Control Wire Connectors: 14-Gauge water-tight connectors per manufacturer’s recommendations, or equal.

G. Electrical Conduit and Fittings: High-impact Schedule 40 PVC C-2000 compound, UL approved, gray color, size as required. Solvent-weld fittings.

H. Lay wire in trenches adjacent to mainline or lateral lines for maximum protection. Place wires 18 inches below grade in electrical conduit where there are no pipes in the trench.

I. Provide 24 inches expansion loops at least every 100 feet in runs of more than 100 feet in length, at changes in direction along the mainline, and at entrance and exits to all sleeves under paving. Provide 24-inch expansion coils at connection to control valves. Provide expansion loops in neat 1-inch diameter coils.

J. Coordinate communication wiring installation with electrical contractor, from controller location to building control and communication system.

3.8 VALVE INSTALLATION

A. Control Valves: Install in underground piping in boxes for automatic control valves.

B. Install plumb to grade in a neat and uniform pattern as per manufacturer's directions, and as shown on Drawings.

C. Thoroughly flush supply lines before installing irrigation control valves.

D. Provide threaded unions at each end of automatic control valve.

E. Follow manufacturer's instructions and adjust pressure regulating module to achieve optimum operating pressure for each zone.

3.9 FLUSHING:

A. Flush lines with water for a minimum of 5 minutes each zone prior to installation of irrigation heads.

B. Cap risers immediately after flushing.

3.10 SPRINKLER INSTALLATION

A. Install sprinklers after hydrostatic test is completed.

B. Install sprinklers at manufacturer's recommended heights.

C. Locate part-circle sprinklers to maintain a minimum distance of 4 inches from walls and 2 inches from other boundaries unless otherwise indicated.

3.11 AUTOMATIC IRRIGATION-CONTROL SYSTEM INSTALLATION

A. Equipment Mounting: Install interior controllers on wall.

1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.12 PIPING SCHEDULE

A. Install components having pressure rating equal to or greater than system operating pressure.

B. Piping in control-valve boxes and aboveground may be joined with flanges or unions instead of joints indicated.

C. Underground irrigation main piping, shall be of the following:
1. PVC, Schedule 40, PVC socket fittings and solvent-cemented joints.
2. For future use, C900 DR18, PVC gasketed pipe and leemco joint restraints.

D. Circuit piping, shall be one of the following:
1. SDR 21, PVC, pressure-rated pipe; Class 200, PVC socket fittings; and solvent-cemented joints.

E. Underground Branches and Offsets at Sprinklers and Devices: Schedule 80, PVC pipe; threaded PVC fittings; and threaded joints.

1. Option: Plastic swing-joint assemblies, with offsets for flexible joints, manufactured for this application.

3.13 CONNECTIONS

A. Install piping adjacent to equipment, valves, and devices to allow service and maintenance.

B. Connect wiring between controllers and automatic control valves.

3.14 PRESSURE TESTING

A. Notify the Owner's Representative five days before pressure testing.

B. Backfill trenches sufficiently to ensure the stability of pipe, leaving joints exposed.

C. Mainline may be tested at different times to allow isolation of either

D. Supply certified pressure gauge and force pump during tests.

E. Mainline Testing:

1. Thoroughly flush piping before testing. Cap all fittings on mainline fill with water.
2. Test mainlines to control valves at 100 psi for 1 hour. If pressure loss occurs, inspect the entire system, make water-tight, and retest until no pressure loss occurs for the testing period.
3. Pressure test must show no pressure loss for the specified period and be accepted by the Owner's Representative before backfill of trenches will be allowed.

3.15 IRRIGATION HEADS

A. Install irrigation heads after pressure test approval.

B. Install sprinkler heads of types, sizes, and coverage at locations shown on Drawings.

C. Minor changes in head location may be necessary to achieve head to head coverage at no additional cost to Owner. Notify Owner's Representative for approval prior to making any changes. Document all changes on Project Site As-built Drawings as they occur.

D. Provide freedom of movement at all swing and swivel joints.

E. Adjust and set for optimum performance as shown on Drawings.

F. Locate heads adjacent to planters, mowstrips, walks, pavement, and curbs with a 2-inch minimum and 3-inch maximum clearance between head and hard surface.

G. Locate no head closer than 6 inches from building foundation.

H. Install protective concrete sprinkler blocks on sprinkler heads adjacent to vehicular paving where heads are not protected by curbs as approved by the Owner's Representative.

3.16 IDENTIFICATION

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each automatic controller.

1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

B. Warning and Marking Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches.

3.17 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

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

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Any irrigation product will be considered defective if it does not pass tests and inspections.

E. Control system shall include required grounding, and shall be fully programmed for initial systems watering program; ‘cool weather’ and ‘hot weather’ programming in addition to meeting the watering window requirements as stated on the plans and within these specifications. Control valves shall be logically numbered on the record drawings and coordinated with the station numbers on the Controller; with all programs provided at the controller in laminated sheets. Controller programming shall include at a minimum:
1. Valve station number.
2. Identification of valve decoder.
3. Start time
4. Station duration
5. Station gallons-per-minute.
6. Station days-per-week of operations
7. Cycle and soak functions to minimize runoff.

F. Control system shall be checked for: High-flow and low-flow operations within range of designed system; variable speed drive operation; and emergency operations such as a pipe break, power failure, pump failure etc.

G. Prepare test and inspection reports.

3.18 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that controllers are installed and connected according to the Contract Documents.
3. Verify that electrical wiring installation complies with manufacturer's submittal.

3.19 ADJUSTING

A. Adjust settings of controllers.

B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.

C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with, or not more than 1/2 inch above, finish grade.

3.20 CLEANING

A. Flush dirt and debris from piping before installing sprinklers and other devices.

3.21 IRRIGATION MAINTENANCE

A. Furnish service and maintenance for one year after Date of Substantial Completion of the entire project.

1. Maintenance Period: Landscape and irrigation maintenance shall be performed from 15th of March through 1st of November. Should the one-year maintenance period not be completed by the 1st of November, the maintenance period shall be continued the following year at no additional cost to the Owner, beginning on 15th of march and extending until the required maintenance period is complete.

3.22 GUARANTEE

A. The Contractor shall guarantee the satisfactory operation of the entire system and the workmanship and restoration of the Project. The entire system shall be guaranteed to be completed and perfect in every detail for a period of one-year from the date of its acceptance and the Contractor agrees to repair or replace any such defects occurring

within that year, at the Contractor’s sole expense. The Contractor shall be responsible for correcting ground settlement over any trenches and/or excavation that are a part of the work for a period of one (1) year.

3.23 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain automatic control valves and controllers.

END OF SECTION 328400

SECTION 329113 - SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes planting soils specified by composition of the mixes.

B. Related Requirements:
   1. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
   2. Section 329300 "Plants" for placing planting soil for plantings.

1.3 ALLOWANCES

A. Field quality-control testing is part of testing and inspecting allowance.

1.4 DEFINITIONS

A. AAPFCO: Association of American Plant Food Control Officials.

B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Imported Soil: Soil that is transported to Project site for use.

F. Layered Soil Assembly: A designed series of planting soils, layered on each other that together produce an environment for plant growth.

G. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

H. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through inter-laboratory sample exchanges and statistical evaluation of analytical data.

I. Organic Matter: The total of organic materials in soil exclusive of un-decayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

J. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

K. SSSA: Soil Science Society of America.

L. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

M. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

N. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

O. USCC: U.S. Composting Council.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for application and use.
2. Include test data substantiating that products comply with requirements.
3. Include sieve analyses for aggregate materials.
4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:

    a. Manufacturer's qualified testing agency's certified analysis of standard products.
    b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
    c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

B. Samples:

1. For each bulk-supplied material, ½ cubic foot volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For each testing agency.

B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

C. Field quality-control reports.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1. Multiple Laboratories: At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil or imported soil.

1. Notify Landscape Architect three days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.10 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken by Contractor under the direction of the testing agency.

1. Number and Location of Samples: Minimum of three representative soil samples from varied locations for each soil to be used or amended for landscaping purposes. Locations to be approved by Owner’s Representative.
2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.11 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":

a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
b. Hydrometer Method: Report percentages of sand, silt, and clay.

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D698 (Standard Proctor).

C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT WERA-103, including the following:

1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
5. Nitrogen ppm.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
9. Manganese-availability ppm.
10. Zinc ppm.
11. Zinc availability ppm.
12. Copper ppm.
13. Sodium ppm and sodium absorption ratio.
14. Soluble-salts ppm.
15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
16. Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy,

viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inch depth of soil.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inch depth of soil.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.

B. Planting-Soil Type On-Site Topsoil: Existing, on-site surface soil, retained; and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

1. Ratio of Loose Compost to Soil: 1:4 by volume.

C. Planting-Soil Type Import Topsoil: Imported, naturally formed soil from off-site sources and consisting of sandy loam or loam soil according to USDA textures; and modified to produce viable planting soil.

1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.

2. Additional Properties of Imported Soil before Amending: Soil reaction of pH 6 to 8 and minimum of 6 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
3. Unacceptable Properties: Clean soil of the following:

    a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
    c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1-1/2 inches in any dimension.

4. Amended Soil Composition: Blend imported, unamended soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

    a. Ratio of Loose Compost to Soil: 1:4 by volume.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
2. Class: O, with a minimum of 95 percent passing through a No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
3. Form: Provide lime in form of ground dolomitic limestone or calcitic limestone.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Agricultural Gypsum: Minimum 90 percent calcium sulfate or 85 percent calcium sulfate dihydrate, finely ground with 90 percent passing through a No. 50 sieve.

F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C33/C33M.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
1. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
2. Reaction: pH of 5.5 to 8.

3. Soluble-Salt Concentration: Less than 4 dS/m.
4. Moisture Content: 35 to 55 percent by weight.
5. Organic-Matter Content: 50 to 60 percent of dry weight.
6. Particle Size: Minimum of 100 percent passing through a 1-inch sieve.

2.4 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

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

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

B. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

C. Screening: Pass unamended soil through a 1 1/2-inch sieve to remove large materials.

3.3 BLENDING PLANTING SOIL IN PLACE

A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of 6 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Mixing: Apply soil amendments, except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.

1. Mix lime and sulfur with dry soil before mixing fertilizer.
2. Mix fertilizer with planting soil no more than seven days before planting.

D. Compaction: Compact blended planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply compost component of planting-soil mix 4 inches of to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329113

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Sodding

B. Related Requirements:

   1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
2. Experience: Three years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:

    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Lawn Care Manager.
    c. Landscape Industry Certified Lawn Care Technician.

5. Pesticide Applicator: State licensed, commercial.

B. Schedule: Sodding operations must be completed by the following dates to ensure lawn can be used by the opening of the school year:
1. Sodding: Sodded lawn must be installed by the third week of June 2025, with approval of the sodded lawn areas and the onset of maintenance operations per the requirements of this Section, being complete by July 1, 2025, upon which the 100 day warranty & maintenance period will begin.
    a. The Contractor shall fertilize, replace damaged sections, and maintain the sodded lawns as necessary, responding to both weather conditions and schedule requirements, to deliver an acceptable stand of grass no later than July 1, 2025, upon which the 100-day maintenance period will begin.
    b. Protection: All sodded lawn areas shall be protected from access and use prior to the full release for use, through the means of temporary fencing and site controls.

1.7 DELIVERY STORAGE AND HANDELING

A. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.8 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion. Sodding shall take place between April 1st and July 1.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOD

A. Turfgrass Sod: Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.

B. Turfgrass Sod: Basin Sod or approved equal. 13218 HWY 395 Eltopia, WA 99330. Phone: 509-545-6330, Sod of grass species as follows, 98% Kentucky bluegrass, 2% perennial ryegrass, grown on a sandy loam soil medium. No less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

2.2 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition:

a. 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition:

a. 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.3 MULCHES

A. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

D. Asphalt Emulsion: ASTM D977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.4 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect grade stakes set by others until directed to remove them.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade or place manufactured planting soil over exposed subgrade.

   1. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints at locations shown on the documents. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

   1. Lay sod across slopes exceeding 1:4.
   2. Anchor sod on slopes exceeding 1:3 with steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.5 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

   1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.

2. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
1. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Finish Lawn: Once growth has reached 4 inches, mow and cut no more than 1/3 total height of grass. Mow weekly thereafter to maintain a height of 2 inches. Maintain until Final Acceptance.

D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.6 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:
1. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.7 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.8 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.9 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:

1. Sodded Turf: 100 days from date of planting completion .

END OF SECTION 329200

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Landscape edgings.
3. Mulch.

B. Related Requirements:
1. Section 329200 "Turf and Grasses" for turf (lawn), hydroseeding, and erosion-control materials.

1.3 ALLOWANCES

A. Allowances for plants are specified in Section 012100 "Allowances."

1. Perform planting work under quantity allowances and only as authorized. Authorized work includes work required by Drawings and the Specifications and work authorized in writing by Landscape Architect.
2. Notify Landscape Architect weekly of extent of work performed that is attributable to quantity allowances.
3. Perform work that exceeds quantity allowances only as authorized by Change Orders.

1.4 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

E. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

F. Finish Grade: Elevation of finished surface of planting soil.

G. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

H. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

I. Planting Area: Areas to be planted.

J. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for planting soils placement.

K. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

L. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

M. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

N. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.5 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.

B. Samples for Verification: For each of the following:
   1. Organic and Compost Mulch: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
   2. Root Barrier: Width of panel by 12 inches.
   3. Mineral Mulch: 2 lb of each mineral mulch required, in sealed plastic bags labeled with source of mulch. Sample shall be typical of the lot of material to be delivered and installed on the site; provide an accurate indication of color, texture, and makeup of the material.
   4. Mycorrhizal Fungi.

1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

   1. Manufacturer's certified analysis of standard products.
   2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

D. Sample Warranty: For special warranty.

1.9 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

   1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
   2. Experience: Three years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
   3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:

      a. Landscape Industry Certified Technician.
      b. Landscape Industry Certified Horticultural Technician.

   5. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.

C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball.

E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
   1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
   2. Do not remove container-grown stock from containers before time of planting.
   3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.12 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Conditions: Planting not permitted during the following conditions, unless otherwise approved:

   1. Cold weather: less than 32 degrees Fahrenheit.
   2. Hot weather: greater than 80 degrees Fahrenheit.
   3. Wet weather: saturated soil.
   4. Windy weather: wind velocity greater than 20 m.p.h.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.13 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

   1. Failures include, but are not limited to, the following:

      a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
      b. Structural failures including plantings falling or blowing over.
      c. Faulty performance of tree stabilization and edgings.
      d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

   2. Warranty Periods: From date of Substantial Completion.

      a. Trees, Shrubs, Vines, and Ornamental Grasses: 24 months.
      b. Ground Covers, Biennials, Perennials, and Other Plants: 24 months.

   3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: 10-gram tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

A. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 1-inch sieve; soluble-salt content of 2 to 5 dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of following type, size range, and color:

1. Type: Crushed basalt, 1 1/2”

2. Storm Facility Rock Mulch, crushed basalt 2” depth. Shrub Bed Rock Mulch: 2” depth

3. Color: Uniform tan-beige color range acceptable to Landscape Architect.

2.4 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 LANDSCAPE EDGINGS

A. Concrete Edging: As shown on Drawings

2.6 MISCELLANEOUS PRODUCTS

A. Wood Pressure-Preservative Treatment: AWPA U1, Use Category UC4a; acceptable to authorities having jurisdiction, and containing no arsenic or chromium.

B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

C. Burlap: Non-synthetic, biodegradable.

D. Root Barrier: Black, molded, modular panels manufactured with 50 percent recycled polyethylene plastic with ultraviolet inhibitors, 85 mils thick, with vertical root deflecting ribs protruding 3/4 inch out from panel, and each panel 24 inches wide.

E. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

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

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

C. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

B. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

C. Application of Mycorrhizal Fungi: At time directed by Architect, broadcast dry product uniformly over prepared soil at application rate according to manufacturer's written recommendations.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately three times as wide as ball diameter for balled and burlapped, balled and potted, container-grown and fabric bag-grown stock.
3. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
7. Maintain supervision of excavations during working hours.
8. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
1. Planting backfill soil mix shall be as follows: 1/4 compost material, 1/4 amended topsoil and 1/2 soil excavated from planting pit.
2. After placing some of backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove

from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.

3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.

    a. Quantity:
        1) 1 gallon shrub = 1 tablet
        2) 2-3 gallon shrub = 2 tablets
        3) 5 gallon shrub or tree = 3 tablets.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

6. Add 3 ounces mycorrhizal inoculum per caliper-inch to backfill around trees. Add 3 tablespoons mycorrhizal inoculum per gallon planting size. Add 1 teaspoon mycorrhizal inoculum per ground cover plant.

D. Balled and Potted and Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Planting backfill soil mix shall be as follows: [1/4] compost material, [1/4] amended topsoil and [1/2] soil excavated from planting pit.
2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.

    a. Quantity:
        1) 1 gallon shrub = 1 tablet
        2) 2-3 gallon shrub = 2 tablets
        3) 5 gallon shrub or tree = 3 tablets.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

6. Add 3 ounces mycorrhizal inoculum per caliper-inch to backfill around trees. Add 3 tablespoons mycorrhizal inoculum per gallon planting size. Add 1 teaspoon mycorrhizal inoculum per ground cover plant

E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.7 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.8 ROOT-BARRIER INSTALLATION

A. Install root barrier where trees are planted as shown on Drawings. Align root barrier vertically and run it linearly along and adjacent to the paving or other hardscape elements to be protected from invasive roots for a total distance of 10 feet per tree. If trees are spaced closer, use a single continuous piece of root barrier.

B. Position top of root barrier flush with finish grade.

C. Overlap root barrier a minimum of 12 inches at joints.

D. Do not distort or bend root barrier during construction activities.

E. Do not install root barrier surrounding the root ball of tree.

3.9 PLANTING AREA MULCHING

A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees in Turf Areas: Apply rock mulch ring of 2-inch average thickness, with 24-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.

2. Rock Mulch in Planting Areas: Apply 2-inch average thickness of rock mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.10 INSTALLATION OF EDGING

A. Mow-Strip Installation:

1. Excavate for mow strip as indicated on Drawings.
2. Compact subgrade uniformly beneath mow strip.
3. Apply nonselective, pre-emergent herbicide that inhibits growth of grass and weeds.
4. Place indicated thickness of mulch, fully covering weed barrier.
5. Rake rock mulch to a uniform surface level with adjacent finish grades.

3.11 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.12 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.13 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Provide new trees of same size as those being replaced for each tree of 4 inches or smaller in caliper size.
2. Provide two new tree(s) of 2 inches caliper size for each tree being replaced that measures more than 4 inches in caliper size.
3. Species of Replacement Trees: Same species being replaced.

3.14 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.15 MAINTENANCE SERVICE

A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: 12 months from date of Substantial Completion.

B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: 12 months from date of Substantial Completion.

END OF SECTION 329300

DIVISION 33 – UTILITIES

SECTION 33 10 00 - WATER DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water service, fire-service mains, and irrigation services.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.2 SUBMITTALS

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

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

1.4 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Architect's written permission.

1.5 COORDINATION

A. Coordinate connection to water main with utility company (City of Pasco). Begin coordination early to verify water meter size and include this in schedule to ensure meter is available at necessary time of installation (meters can have long lead times).

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. PE Pipe: AWWA C901, ASTM D2737, 200 psi pipe with copper tubing outside diameter.

1. Molded PE fittings: ASTM D3350 PE resin, socket or butt fusion type, made to match pipe dimensions and class.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, Class 52, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated. Pipe shall be cement mortar lined per AWWA C104.
   1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
      a. Gaskets: AWWA C111, rubber.
      b. Fittings shall be cement mortar lined per AWWA C104.

C. PVC, AWWA Pipe: AWWA C900 or C905, Class 150, with bell end with gasket, and with spigot end.
   1. Comply with UL 1285 for fire-service mains if indicated.
   2. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
      a. Gaskets: AWWA C111, rubber.
      b. Fittings shall be cement mortar lined per AWWA C104.
   3. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
      a. Glands, Gaskets, and Bolts: AWWA C111, ductile or gray-iron glands, rubber gaskets, and steel bolts.

2.2 TRACER WIRE

A. 12 Gauge copper with 60-mil, UF installation color blue for water. City of Pasco pre-approved manufacturer 3M DBY-6.

2.3 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:
   1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
      a. Standard: AWWA C219.

2.4 GATE VALVES

A. AWWA, Cast-Iron Gate Valves (10” and smaller):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Waterous Series 500.
      b. Clow Valve Co.R/W.
      c. Kennedy Ken-Seal.
      d. M & H Valve Style 3067.
      e. Mueller
   2. Nonrising-Stem, Resilient-Seated Gate Valves:
      a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
         1) Standard: AWWAC515.
         2) Minimum Pressure Rating: 200 psig.
         3) End Connections: Mechanical joint.
         4) Interior Coating: Complying with AWWA C550.

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ford.
      b. Romac.
      c. Smith-Blair.

2. Description: Sleeve and valve compatible with drilling machine.
    a. Standard: MSS SP-60.
    b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
    c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER", and bottom section with base that fits over valve and with a barrel approximately 5 1/4 inches in diameter and shall be slip type Sigma, Tyler, or approved equal.
    1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

2.6 WATER METERS

A. Water meters will be furnished by utility company.

2.7 BACKFLOW PREVENTERS

A. Double-Check, Backflow Assembly:
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Watts Water Technologies, Inc.
        b. Wilkins; a Zurn company.
    2. Standard: AWWA C510.
    3. Operation: Continuous-pressure applications, unless otherwise indicated.
    4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
    5. Configuration: Designed for horizontal, straight through flow.
    6. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2 1/2 and larger.

B. Reduced-Pressure-Principle Backflow Preventers:
    1. Manufacturers: Shall be on the Washington Department of Health approved list, and subject to compliance with requirements, provide products by one of the following:
        a. Ames Fire & Waterworks; a division of Watts Regulator Co.
        b. Conbraco Industries, Inc.
        c. FEBCO; SPX Valves & Controls.
        d. Flomatic Corporation.
        e. Watts Water Technologies, Inc.
        f. Wilkins; a Zurn company.
    2. Standard: AWWA C511.
    3. Operation: Continuous-pressure applications.
    4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
    5. Configuration: Designed for horizontal, straight through flow.
    6. Accessories:
        a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
        b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

2.8 CONCRETE VAULTS

A. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858.
    1. Ladder: ASTM A 36, steel or polyethylene-encased steel steps.
    2. Manhole: ASTM A 48 Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.
        a. Dimension: 24 inch minimum diameter, unless otherwise indicated.
    3. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron traffic frame and cover.
        a. Dimension: 24 inch minimum diameter, unless otherwise indicated.

2.9 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Clow (Medallion).
      b. Waterous (Pacer WD67).
      c. Mueller (Centurion).
   2. Description: Fire hydrants shall conform to AWWA C502. Hydrant shall have 5 1/4" main operating valve with two 2 1/2” NST nozzles and one 4” NST pumper nozzle. Hydrant operating nut shall be a 1 1/2" pentagon. Hydrants shall have a minimum bury depth of 42” and shall be painted safety yellow.
      a. Standard: AWWA C502.

2.10 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections:
   1. Description: Either freestanding or mounted on the building as shown on the civil plans.
      a. As specified by fire sprinkler designer.

2.11 INDICATOR POST

A. Indicator Post for Post indicator valve:
   1. Description: Freestanding, with cast-iron body, “open or shut” target indicator, operating wrench, pad lockable, with supervisory switch mounting connection.
      a. Standard: UL and FM approved.
      b. Finish: painted red.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
C. Do not use flanges or unions for underground piping.
D. Flanges, unions, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
E. Underground water and irrigation service piping as indicated on drawings.
F. Aboveground and vault water-service Piping NPS 3/4 to NPS 3 as indicated on drawings.
G. Aboveground and vault water-service piping NPS 4 and above shall be the following:
   1. Ductile-iron or PVC as indicated on the drawings.
H. Underground Fire-Service-Main Piping as indicated on drawings.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.
B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.
   2. Underground Valves, NPS 4 and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.

3. Use the following for valves in vaults and aboveground:
    a. Gate Valves, NPS 2 and Smaller: Bronze, rising stem.
    b. Gate Valves, NPS 3 and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated.

3.4 PIPING INSTALLATION

A. Water-Main Connection: Connect water main according to requirements of water utility company and of size and in location indicated.
B. Comply with NFPA 24 for fire-service-main piping materials and installation.
C. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
D. Install PE pipe according to ASTM D 2774 and ASTM F 645.
E. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
F. Bury piping with depth of cover over top at least 42 inches.
G. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
    1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
H. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
I. Installation of firewater lines shall be by a Level U installer.

3.5 JOINT CONSTRUCTION

A. Make pipe joints according to the following:
    1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
    2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
    3. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
    4. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions
    5. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
    6. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.6 TRACER WIRE INSTALLATION

A. Tracer wire shall be installed on all watermains regardless of material type and shall be direct bury.

3.7 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
    1. Concrete thrust blocks.
    2. Locking mechanical joints.
    3. Set-screw mechanical retainer glands.
    4. Bolted flanged joints.
    5. Heat-fused joints.
    6. Pipe clamps and tie rods.
B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
    1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
    2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
    3. Fire-Service-Main Piping: According to NFPA 24.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

3.9 WATER METER INSTALLATION

A. Install water meters, piping, and specialties according to utility company's written instructions.

3.10 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2 1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.11 CONCRETE VAULT INSTALLATION

A. Install precast concrete vaults according to ASTM C 891.

3.12 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. AWWA Fire Hydrants: Comply with AWWA M17.

3.13 FIRE DEPARTMENT CONNECTION INSTALLATION

A. General: Install per direction of fire sprinkler designer.

B. Install in accordance with the manufacturer’s written directions.

C. UL/FM Fire Department Connections shall comply with NFPA 13.

3.14 POST INDICATOR INSTALLATION

A. General: Install post indicator and support in upright position.

B. Install in accordance with the manufactures written directions.

C. UL/FM Post indicators shall comply with NFPA 13.

3.15 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Test in accordance with City of Pasco requirements. Use only potable water. Fire water lines and hydrants shall be tested to 200 PSI.

3.16 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving".

3.17 CLEANING

A. Clean and disinfect water-distribution piping shall be in accordance with the City of Pasco requirements.

3.18 TRACER WIRE INSTALLATION

A. Tracer wire shall be installed on all watermains regardless of material type and shall be direct bury.

END OF SECTION 33 10 00

SECTION 33 30 00 - SANITARY SEWERS

PART 1 - GENERAL

1.1 SUMMARY
- A. Section Includes:
  1. Pipe and fittings.
  2. Cleanouts.
  3. Manholes.

1.2 SUBMITTALS
- A. Product Data: For pipe and fittings.
- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.
- C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
- D. Field quality-control reports.

1.3 QUALITY ASSURANCE
- A. Regulatory Requirements:
  1. Comply with standards of authorities having jurisdiction for sanitary sewer piping, including materials, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with ASTM D 2321 and installation of thermoplastic drainage piping.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS
- A. PVC Sewer Piping:
  1. Pipe: ASTM D 3034, SDR 35, PVC sewer pipe with bell-and-spigot ends for gasketed joints. SDR 26 for all sewer pipe with any portion of the sewer main greater than 12 feet of cover.
  2. Fittings: ASTM D 3034, PVC with bell ends.
  3. Gaskets: ASTM F 477, elastomeric seals.

2.2 NONPRESSURE-TYPE TRANSITION COUPLINGS
- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Unshielded, Flexible Couplings:
  1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

2.3 TRACER WIRE
- A. 12 Gauge copper with 60-mil, UF installation color blue for water. City of Pasco pre-approved manufacturer 3M DBY-6.

2.4 CLEANOUTS
- A. Cast-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
  1. Top-Loading Classification(s): Heavy Duty.
  2. Sewer Pipe Fitting and Riser to Cleanout: PVC pipe and fittings.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:
   1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   2. Diameter: 48 inches minimum unless otherwise indicated.
   3. Base Section: 6 inch minimum thickness for floor slab and 4 inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
   4. Riser Sections: 4 inch minimum thickness, of length to provide depth indicated.
   5. Top Section: concentric-cone type is indicated; with top of cone of size that matches grade rings.
   6. Precast concrete cones shall be eccentric.
   7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
   8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
   9. Steps: Manhole steps shall be co-polymer polypropylene steel reinforced steps. The steel core shall be a minimum one-half inch steel bar fully enclosed in the co-polymer polypropylene. Steps shall meet all requirements of ASTM C-478 and shall be rated for a minimum 300-foot pound concentrated load and meet the latest OSHA requirements.
   10. Grade Rings: Reinforced-concrete rings, 6 to 9 inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
   11. Where installed in conjunction with street construction, the channelization and manhole bases shall be covered by a rigid material such as 3/4-inch plywood or better. This cover shall remain in place until street construction is complete and the manhole castings are grouted and then shall be removed along with all the debris prior to acceptance of construction.
   12. Manhole sections installed below the high static groundwater level shall be infiltration tested. A water infiltration allowance of 0.20 gallons per hour, per foot of static head above the lowest manhole invert, shall be considered as a satisfactory manhole test.

B. Manhole Frames and Covers:
   1. Description: Ferrous; 24 inch ID by 7 to 9 inch riser, with 4 inch minimum-width flange and 26 inch diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER".
   2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.6 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350, and the following:
   1. Cement: ASTM C 150, Type II.
   2. Fine Aggregate: ASTM C 33, sand.
   3. Coarse Aggregate: ASTM C 33, crushed gravel.
   4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
   1. Reinforcing Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcing Bars: ASTM A 615, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      a. Invert Slope: 1 percent through manhole.

PART 3 - EXECUTION

3.1 EARTHWORK

Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving".

3.2 PIPING INSTALLATION

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

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

C. Install manholes where indicated on drawings.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

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

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
2. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 TRACER WIRE INSTALLATION

A. Tracer wire shall be installed on all sewer lines regardless of material type and shall be direct bury.

3.4 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 1 inch above finished surface elsewhere unless otherwise indicated.

E. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.6 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep, unless otherwise indicated. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping".

B. Make connections to existing piping and underground manholes.

3.8 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving". Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
   1. Submit separate report for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into piping.
      e. Exfiltration: Water leakage from or around piping.
   3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   1. Do not enclose, cover, or put into service before inspection and approval.
   2. Test completed piping systems according to requirements of authorities having jurisdiction.
   3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   4. Submit separate report for each test.
   5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
      a. Fill sewer piping with water. Test with pressure of at least 10 foot head of water, and maintain such pressure without leakage for at least 15 minutes.
      b. Close openings in system and fill with water.
      c. Purge air and refill with water.
      d. Disconnect water supply.
      e. Test and inspect joints for leaks.
   6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
      a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
      b. Option: Test concrete gravity sewer piping according to ASTM C 924.
   7. Manholes: Perform hydraulic test according to ASTM C 969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 33 30 00

SECTION 33 40 00 - STORM DRAINAGE

PART 1 - GENERAL

1.1 SUMMARY
- A. Section Includes:
  1. Pipe and fittings.
  2. Cleanouts.
  3. Catch basins.

1.2 SUBMITTALS
- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
  1. Catch basins: Include plans, elevations, sections, details, frames, covers, and grates.
- C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
- D. Field quality-control reports.

1.3 QUALITY ASSURANCE
- A. Regulatory Requirements:
  1. Comply with standards of authorities having jurisdiction for storm drainage piping, including materials, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with ASTM D 2321 and installation of thermoplastic drainage piping.

PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS
- A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
  1. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.
  2. Perforated pipe shall have AASHTO Class II perforations.
- B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
  1. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.2 PVC PIPE AND FITTINGS
- A. PVC Drainage Piping:
  1. Pipe: ASTM D 3034, SDR 35, PVC drainage pipe with bell-and-spigot ends for gasketed joints.
  2. Fittings: ASTM D 3034, PVC with bell ends.
  3. Gaskets: ASTM F 477, elastomeric seals.
- B. Perforated storm drainage pipe shall be PVC or corrugated polyethylene (PE) tubing and fittings with smooth interior manufactured to ASHTO M-252 and M-294.

2.3 NONPRESSURE TRANSITION COUPLINGS
- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
  1. For Concrete Pipes: ASTM C 443, rubber.
  2. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
  3. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

4. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:
1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:
1. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:
1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.4 CLEANOUTS

A. Cast-Iron Cleanouts:
1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Heavy Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.5 CATCH BASINS

A. Standard Precast Concrete Catch Basins:
1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Base Section: 6 inch minimum thickness for floor slab and 4 inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: 4 inch minimum thickness, 48 inch diameter, and lengths to provide depth indicated.
4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
7. Grade Rings: Include two or three reinforced-concrete rings, of 6 to 9 inch total thickness, that match 24 inch diameter frame and grate.
8. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.
1. Size: 24 by 24 inches minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24 inch ID by 7 to 9 inch riser with 4 inch minimum width flange, and 26 inch diameter flat grate with small square or short-slotted drainage openings.
1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

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

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

C. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

D. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

E. Install gravity-flow, nonpressure drainage piping according to the following:
   1. Install piping pitched down in direction of flow.
   2. Install PE corrugated sewer piping according to ASTM D 2321.
   3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

F. Clear interior of piping and catch basins of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from drainage pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in drainage pipe.
   1. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.4 CATCH BASIN INSTALLATION

A. Set frames and grates to elevations indicated.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.6 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains.

3.7 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
   1. Use detectable warning tape over ferrous piping.
   2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.8 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
   1. Submit separate reports for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.

c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
b. Option: Test plastic piping according to ASTM F 1417.
c. Option: Test concrete piping according to ASTM C 924.

C. Leaks and loss in test pressure constitute defects that must be repaired.
D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 33 40 00