SANTA ANA COLLEGE

Johnson Student Center

1530 W. 17TH STREET, SANTA ANA, CA 92706

INCREMENT 2

NEW BUILDING

Technical Specifications
Volume 2

August 13, 2018

HPI architecture

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SANTA ANA COLLEGE

Johnson Student Center

1530 W. 17TH STREET, SANTA ANA, CA 92706

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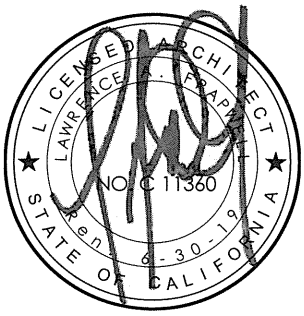

08.06.2018

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IDENTIFICATION STAMP
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04 116810

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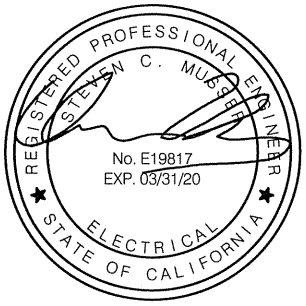

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SANTA ANA COLLEGE
JOHNSON STUDENT CENTER (INCREMENT 2)

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SECTION 101116 – MARKER BOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Markerboards.

B. Related Sections include the following:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.

1.2 SUBMITTALS

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

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1 Low-Emitting Materials - Adhesive and Sealants: Provide VOC content data for materials used. Data typically available in manufacturer spec or MSDS. Comply with VOC limits from Division 1 Section "Sustainable Design Requirements". Include LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".

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

D. Schedule: List product, size, and type by room numbers.

E. Samples for Initial Selection: For each type of visual display surface indicated and as follows:
   1. Actual sections of face sheet and tack assembly.
   2. Fabric swatches of faced tack assemblies.
   3. Samples of accessories involving color selection.

F. Samples for Verification: For each type of visual display surface indicated and as follows:
   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. Rail Support System: 6-inch- long sections.
   4. Accessories: Full-size Sample of each type of accessory.

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

H. Maintenance Data: For visual display surfaces to include in maintenance manuals.

I. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

A. Reference Standards:
1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
6. 2016 California Energy Code, Part 6, Title 24 CBSC.
7. 2016 California Historical Code, Part 8, Title 24 CBSC.
8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
15. NFPA 20 - Stationary Pumps, 2016 Edition.
16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

B. Source Limitations: Obtain each type of visual display surface through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of visual display surfaces and are based on the specific system indicated. Refer to Division 1 Section "Product 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.

D. Fire-Test-Response Characteristics: Provide fabrics with the surface-burning characteristics indicated, as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-built visual display boards, 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 units vertically with packing materials between each unit.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating visual display surfaces without field measurements. Coordinate wall construction to ensure that actual dimensions correspond to established dimensions.
   2. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.6 WARRANTY

A. Special Warranty for Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace 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 become slick or shiny.
      c. Surfaces exhibit crazing, cracking, or flaking.
   2. Warranty Period: Life of the building.

B. Installer's Warranty: 2 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Markerboard: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
   1. Claridge Products & Equipment, Inc.; (Basis of Design).
   2. A-1 Visual Systems.
   3. Polyvision Corporation
   4. Chatfield Clarke Co.
   5. Platinum Visual Systems.
   6. Or equal.

2.2 MARKERBOARDS

A. Product: Markerboard by Claridge Products & Equipment, Inc.
   1. Face Sheet: 24 gauge, white.
      a. LCS-II, 75 low gloss; dry-erase markers wipe clean with dry cloth or standard eraser. Suitable for use as projection screen.
   2. Core Material: 7/16" MDF unless fire retardant materials are required, then provide 7/16 inch Duracore.
   3. Panel Backing: Moisture barrier back; 0.002" Aluminum Foil Panel.
   4. Metal Frame/Trim: Series #4, 5/8 inch trim face.
      a. Extruded aluminum, alloy 6063, clear anodized finish.
      b. Trim for three sides: Side trim with narrow leg exposed and mitered at corners.
      c. Chalk trough: Outer end corners rounded to approximately 1-1/2 inches radius.
   5. Size: As indicated on Drawings.
   6. Maprail: 74EZ, 2 inch.

2.3 ACCESSORIES

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

B. Chalktray: Manufacturer's standard, continuous.
   1. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.

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 assemble 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.
   2. Provide manufacturer's standard vertical-joint spline 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 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.

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.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

B. Examine walls and partitions for proper backing for visual display surfaces.

C. Examine walls and 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. Remove dirt, scaling paint, projections, and depressions that will affect smooth, finished surfaces of visual display boards.

B. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, and substances that will impair bond between visual display boards and visual display fabric and surfaces.
   1. Seal wall surfaces indicated to receive visual display fabric.

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. Units shall be braced in place to allow curing of adhesive. There shall be no gaps or voids in adhesion and units shall not give when pushed.

3.4 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY UNITS

A. Visual Display Boards: Visual Display Boards shall be attached to the wall by spreading adhesive over the entire back of the panel with 1/4 inch notched trowel. Panels shall be braced to provide thorough adhesion to the substrate, and shall exhibit no "sponginess" when pressed.

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 101116

SECTION 101123 – TACK BOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Tackboards.

B. Related Sections include the following:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.

1.2 SUBMITTALS

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

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1 Low-Emitting Materials - Adhesive and Sealants: Provide VOC content data for materials used. Data typically available in manufacturer spec or MSDS. Comply with VOC limits from Division 1 Section "Sustainable Design Requirements". Include LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".

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

D. Schedule: List product, size, and type by room numbers.

E. Samples for Initial Selection: For each type of visual display surface indicated and as follows:
   1. Actual sections of face sheet and tack assembly.
   2. Fabric swatches of faced tack assemblies.
   3. Samples of accessories involving color selection.

F. Samples for Verification: For each type of visual display surface indicated and as follows:
   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. Rail Support System: 6-inch- long sections.
   4. Accessories: Full-size Sample of each type of accessory.

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

H. Maintenance Data: For visual display surfaces to include in maintenance manuals.

I. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

A. Reference Standards:
1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
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14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
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19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

B. Source Limitations: Obtain each type of visual display surface through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of visual display surfaces and are based on the specific system indicated. Refer to Division 1 Section "Product 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.

D. Fire-Test-Response Characteristics: Provide fabrics with the surface-burning characteristics indicated, as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-built visual display boards, 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 units vertically with packing materials between each unit.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating visual display surfaces without field measurements. Coordinate wall construction to ensure that actual dimensions correspond to established dimensions.
   2. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.6 WARRANTY

A. Special Warranty for Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace 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 become slick or shiny.
      c. Surfaces exhibit crazing, cracking, or flaking.
   2. Warranty Period: Life of the building.

B. Installer's Warranty: 2 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Tackboard: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
   1. Claridge Products & Equipment, Inc.; (Basis of Design).
   2. A-1 Visual Systems.
   3. Polyvision Corporation
   4. Chatfield Clarke Co.
   5. Platinum Visual Systems.
   6. Or equal.

2.2 TACK BOARD

A. Product: Series 5 by Claridge Products & Equipment, Inc. or equal.
   1. 5/8 inch wide perimeter trim.
   2. Tack Surface: Claridge Cork.
   3. Satin anodized aluminum frame.
   4. Panel thickness: 1 inch.
   5. Size: As indicted on Drawings.

2.3 ACCESSORIES

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

B. Chalktray: Manufacturer's standard, continuous.
   1. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.

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 assemble 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.
   2. Provide manufacturer's standard vertical-joint spline 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 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.

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.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

B. Examine walls and partitions for proper backing for visual display surfaces.

C. Examine walls and 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. Remove dirt, scaling paint, projections, and depressions that will affect smooth, finished surfaces of visual display boards.

B. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, and substances that will impair bond between visual display boards and visual display fabric and surfaces.
   1. Seal wall surfaces indicated to receive visual display fabric.

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. Units shall be braced in place to allow curing of adhesive. There shall be no gaps or voids in adhesion and units shall not give when pushed.

3.4 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY UNITS

A. Visual Display Boards: Visual Display Boards shall be attached to the wall by spreading adhesive over the entire back of the panel with 1/4 inch notched trowel. Panels shall be braced to provide thorough adhesion to the substrate, and shall exhibit no "sponginess" when pressed.

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 101123

SECTION 101300 - DIRECTORIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Non-illuminated, changeable-letter directories.

B. Related Sections:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.

1.2 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for directories.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1 Low-Emitting Materials - Adhesive and Sealants: Provide VOC content data for materials used. Data typically available in manufacturer spec or MSDS. Comply with VOC limits from Division 1 Section "Sustainable Design Requirements". Include LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".

C. Samples for Verification: For each type of directory indicated as follows:
   1. Letterboards: 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. Letters: Full-size Samples of changeable letters of each size specified.

D. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Reference Standards:
   1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
   2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
   3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
   4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
   5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
   6. 2016 California Energy Code, Part 6, Title 24 CBSC.
   7. 2016 California Historical Code, Part 8, Title 24 CBSC.

8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
15. NFPA 20 - Stationary Pumps, 2016 Edition.
16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

B. Source Limitations: Obtain directories through one source from a single manufacturer.

C. Product Options: Information on Drawings and in Specifications establishes requirements for directories' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including field testing and in-service performance.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of directories and are based on the specific system indicated.
   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 COORDINATION

A. Coordinate installation of anchorage for directories. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of directories that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures of cabinets or frames.
      b. Faulty operation of hardware.

c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Five years.

B. Installer's Warranty: 2 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Non-illuminated, Changeable-Letter Directory:
1. Message Board, Model B by Poblocki Sign Co. (Basis of Design)
2. ASI Sign Systems, Inc.
3. Best Manufacturing Co.
4. Or equal.

2.2 NON-ILLUMINATED, CHANGEABLE-LETTER DIRECTORY

A. Materials and Components:
1. Aluminum Extrusions: Meeting ASTM B221, alloy 6063-T5.
2. Aluminum Panels: Meeting ASTM B209, minimum 0.090" thick.

B. General:
1. Comply with requirements indicated for materials, thickness, finishes, colors, designs, shapes, sizes, and details of construction.
2. 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 on exposed and contact surfaces.
3. Mill joints to a tight, hairline fit.
4. Message Boards to be fully factory assembled. No visible fasteners or knocked-downcases will be acceptable.
5. Form panels to required size and shape. Comply with requirements indicated for design, dimensions, finish, color, and details of construction.
6. Message Boards to be fabricated based on dimensions as shown on architectural drawings.
7. Coordinate dimensions and attachment methods to produce message panels with closely fitting joints. Align edges and surfaces with one another in the relationship indicated.
8. Increase metal thickness or reinforce with concealed stiffeners or backing materials as required to produce surfaces without distortion, buckles, warp, or other surface deformations.
   a. Fabricate frame from extruded aluminum. Corners to have hairline miters and be braced by means of internal aluminum angels. If welding is necessary, none should be visible. Frames shall have a continuous back-up member behind door.
   b. Venting: Provide venting as a recommended by the manufacture to prevent condensation.

C. Mounting:
1. Surface Mounting: Surface mount Message Board flush to wall through back plate.

D. Message Board Construction:
   1. Casing: Aluminum extrusion mitered and assembled with concealed corner angles.
   2. Housing: Aluminum cabinet fully factory assembled with .125" extrusion walls or .090" fabricated aluminum walls and .090" aluminum back (interior or exterior).
   3. Locks: Cam locks for hinged doors.
   4. Hold-open arms: Static.

E. Finishes:
   1. Aluminum with clear anodized finish.

F. Door Profiles:
   1. Provide nonsectional, one-piece cover, mitered and assembled with concealed corner angles, for access to changeable letters, equipped with cam locks keyed alike.
   2. 1/4 inch tempered glazing held in cover frame mounted on an aluminum full-length, continuous piano hinge (interior or exterior).

G. Trim: 3/4" or 1-1/2" or 1-3/4" Aluminum angle or .063" or .090" Aluminum brake metal.

H. Background Types: Black grooved felt.

I. Changeable Letters:
   1. White letters: 3", 4", 6", or 8" in height.

J. Graphics:
   1. As indicated on Drawings or as selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of work.

B. Examine roughing-in for electrical power system to verify actual locations of connections before installation of illuminated directories.

C. Examine walls and partitions for proper backing for directories.

D. Examine walls and partitions for suitable framing depth where recessed directories will be installed.

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

3.2 INSTALLATION

A. General: Install directories 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.

B. Surface-Mounted Directories: Attach directories to wall surfaces with concealed clips, hangers, or grounds fastened at not less than 16 inches o.c. Secure both top and bottom of directories to walls.

3.3 ADJUSTING AND CLEANING

A. Adjust directory doors to operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

END OF SECTION 101300

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SECTION 101400 - SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Panel signs (room signs).
   2. Cast metal signs – building signage.
   3. Parking signs.
   4. Traffic signs.
   5. Signage accessories.
   6. Custom signs.

B. Related Sections:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Raised characters shall comply with CBC Section 11B-703.2.:
      a. Depth: It shall be 1/32 inch (0.8 mm) minimum above their background and shall be sans serif uppercase and be duplicated in Braille.
      b. Height: It shall be 5/8 inch (15.9 mm) minimum and 2 inches (51 mm) maximum based on the height of the uppercase letter "I". CBC Section 11B-703.2.5.
      c. Finish and contrast: Characters and their background shall have a non-glare finish. Character shall contrast with their background with either light characters on a dark background or dark characters on a light background. CBC Section 11B-703.5.1
      d. Proportions: It shall be selected from fonts where the width of the uppercase letter "O" is 60 % minimum and 110 % maximum of the height of the uppercase letter "I". Stroke thickness of the uppercase letter "I" shall be 15 % maximum of the height of the character. CBC Sections 11B-703.4 and 11B-703.6
      e. Character Spacing: Spacing between individual tactile characters shall comply with CBC Section 11B-703.2.7 and 11B-703.2.8.
      f. Braille: It shall be contracted (Grade 2) and shall comply with CBC Sections 11B-703.3 and 11B-703.4. Braille dots shall have a domed and rounded shape and shall comply with CBC Table and Figure 11B-703.3.1.
      g. Mounting height: A tactile sign shall be located 48" minimum to the baseline of the lowest Braille cells and 60" maximum to the baseline of the highest line of raised characters above the finish floor or ground surface.
      h. Mounting location: A tactile sign shall be located on the approach side, as one enters or exits rooms or space, and be reached within 0" of the required clear floor space per CBC Section and Figure 11B -703.4.2 as follows:
      i. Format: Text shall be in horizontal format. CBC Section 11B-703.2.9

1) a clear floor space of 18' x 18" minimum, centered on the tactile characters, shall be provided beyond the arc of any door swings between the closed position and 45 degree open position.
2) on the wall at the latch side of a single door.
3) on the inactive leaf of a double door with one active leaf.
4) on the wall at the right side of a double door with two active leafs.
5) on the nearest adjacent wall where there is no wall space at the latch side of a single door or no space at the right side of a double door with two active leafs.

2. Visual characters shall comply with CBC Section 11B-703.5 and shall be 40" minimum above finish floor or ground.
3. Pictograms shall comply with CBC Section 11B-703.6.
4. Symbol of accessibility shall comply with CBC Section 11B-703.7.
5. Format: Text shall be in horizontal format per CBC Section 11B-703.2.9.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of sign.

B. LEED Submittals:
1. Product Data for Credit IEQ 4.1 Low-Emitting Materials - Adhesive and Sealants: Provide VOC content data for materials used. Data typically available in manufacturer spec or MSDS. Comply with VOC limits from Division 1 Section "Sustainable Design Requirements". Include LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".

C. Shop Drawings: Include plans, elevations, and large-scale sections of typical members and other components. Show mounting methods, grounds, mounting heights, layout, spacing, reinforcement, accessories, and installation details.
1. Provide message list for each sign, including large-scale details of wording, lettering, artwork, and braille layout.
2. Signage weighing 20 pounds or more shall submit anchorage details for DSA approval.

D. Samples for Initial Selection: For each type of sign material indicated that involves color selection.

E. Samples for Verification: For each type of sign, include the following Samples to verify color selected:
1. Panel Signs: Full-size Samples of each type of sign required.
2. Approved samples will not be returned for installation into Project.

F. Qualification Data: For Installer.

G. Maintenance Data: For signage cleaning and maintenance requirements to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Reference Standards:
1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
6. 2016 California Energy Code, Part 6, Title 24 CBSC.
7. 2016 California Historical Code, Part 8, Title 24 CBSC.
8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
15. NFPA 20 - Stationary Pumps, 2016 Edition.
16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

B. Installer Qualifications: An authorized representative of signage manufacturer for installation and maintenance of units required for this Project.

C. Source Limitations: Obtain each sign type through one source from a single manufacturer.

D. Regulatory Requirements: Comply with the Americans with Disabilities Act (ADA) and with code provisions as adopted by authorities having jurisdiction.

1.5 PROJECT CONDITIONS

A. Field Measurements: Where sizes of signs are determined by dimensions of surfaces on which they are installed, verify dimensions by field measurement before fabrication and indicate measurements on Shop Drawings.

1.6 COORDINATION

A. For signs supported by or anchored to permanent construction, advise installers of anchorage devices about specific requirements for placement of anchorage devices and similar items to be used for attaching signs.
   1. For signs supported by or anchored to permanent construction, furnish templates for installation of anchorage devices.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of signage fails in materials or workmanship within specified warranty period.
   1. Warranty Period: 1 year.

B. Installer Warranty: 2 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Signs: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
   1. Best Sign Systems Inc.
   2. ASI Sign Systems, Inc.
   3. Curcio Enterprises, Inc.
   4. Mohawk Sign Systems.
   5. Sign A Rama.
   6. Or equal.

B. Cast Metal Signs: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
   1. Gemini, Inc.
   2. La Haye Bronze.
   3. Metal Arts; Division of L & H Mfg.
   4. Mills Manufacturing. Inc.
   5. Southwell Co.
   6. Or equal.

2.2 PANEL SIGNS

A. General: Provide panel signs that comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.
   1. Produce smooth panel sign surfaces constructed to remain flat under installed conditions within tolerance of plus or minus 1/16 inch measured diagonally.

B. Product: HC300 ADA Sign System by Best Sign Systems.

1. Unframed Panel Signs: Fabricate signs with edges mechanically and smoothly finished.
2. Room, Occupancy, Wayfinding Signs: As selected from 4 standard copy size signs.
   a. 4" x 2" with up to 4 characters each.
   b. 6" x 2" with up to 8 characters each.
   c. 8" x 2" with up to 12 characters each.
   d. 10" x 2" with up to 14 characters each.
3. Toilet Room Signs: As selected from manufacturer's standard.
4. Symbols of Accessibility: Provide 6-inch- high symbol fabricated from opaque nonreflective vinyl film, 0.0035-inch nominal thickness, with pressure-sensitive adhesive backing suitable for both exterior and interior applications.
5. Material:
   a. 1/4 inch thick (thicker than standard) "MP", acrylic sheet, ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).
6. Copy: As indicated on Drawings.

2.3 PARKING SIGNS

A. Material: 0.063" aluminum, screen printed copy on engineer grade reflective vinyl sheeting.
   1. Text: Symbols of accessibility, accessible direction, etc. as indicated on Drawings.

B. Accessible signs are blue with white symbol.

C. Post: 2 inch diameter, schedule 40 galvanized pipe.

2.4 TRAFFIC SIGNS

A. Material: 0.080" aluminum, screen printed copy on engineer grade reflective vinyl sheeting.
   1. Text: Stop, Yield, Do Not Enter, etc. as indicated on Drawings.

B. Post: 2 inch diameter, schedule 40 galvanized pipe.

2.5 FONT

A. Follow campus standard for font, color, and sizes selection as approved by Architect.

2.6 CAST METAL SIGNS – BUILDING SIGNAGE

A. Aluminum Signs:
   1. Extrusions and Plates.
   2. Finish and color: As indicated on Drawings.
   3. Text Type: Match adjacent building as approved by Architect.
   4. Types:
      a. Gift shop and theater signage.
      b. Building identification signage.

2.7 ACCESSORIES

A. Mounting Methods: Use concealed fasteners fabricated from materials that are not corrosive to sign material and mounting surface.

B. 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 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 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 range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Verify that items, including anchor inserts, provided under other sections of Work are sized and located to accommodate signs.

C. Examine supporting members to ensure that surfaces are at elevations indicated or required to comply with authorities having jurisdiction and are free from dirt and other deleterious matter.

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

3.2 INSTALLATION

A. General: Locate signs and accessories where indicated, using mounting methods of types described and in compliance with manufacturer's written instructions.
   1. Install signs level, plumb, and at heights indicated, with sign surfaces free from 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 Panel Signs:
   1. Interior Signs on Smooth Substrates:
      a. Silicone-Adhesive Mounting: Use liquid-silicone adhesive recommended in writing by sign manufacturer to attach signs to irregular, porous, or vinyl-covered surfaces. Use double-sided vinyl tape where recommended in writing by sign manufacturer to hold sign in place until adhesive has fully cured.
   2. Exterior and Interior Signs on Rough Substrates:
      a. Mechanical Fasteners: 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.
         1) Fastener: Stainless steel screws, tamper-resistant flat head countersink.
         2) Anchors: Suitable for secure attachment to substrate.

C. Parking and Traffic Signs
   1. General: Locate sign units and accessories where indicated, using mounting methods of the type described and in compliance with the manufacturer's instructions.
   2. Install sign level, plumb, and at height indicated.
   3. Cap post with galvanized cap.

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 101400

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SECTION 101446 - VINYL WALL GRAPHICS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior vinyl wall graphics.
2. Exterior vinyl wall graphics.

B. Related Sections:

1. Division 1 - General Requirements.

1.02 QUALITY ASSURANCE

A. Reference Standards:

1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
6. 2016 California Energy Code, Part 6, Title 24 CBSC.
7. 2016 California Historical Code, Part 8, Title 24 CBSC.
8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
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16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

B. Comply with following as a minimum requirement:

1. ANSI/NFPA 255 – Standard Method of Test of Surface Burning Characteristics of Building Materials.

2. ANSI/UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

3. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

C. Qualifications:

1. Vinyl Film and Ink Manufacturers: Minimum of ten years manufacturing vinyl films and inks.

2. Graphic Manufacturer: Minimum five years experience in successfully fabricating and installing interior and exterior vinyl graphics.

D. Certifications: Film manufacturer shall certify the following:

1. Graphic and overlay films and inks to be used are compatible.

2. Graphic and overlay films are rated for installation using high heat tools.

1.03 SUBMITTALS

A. LEED Submittals: Product Data for Credit IEQ 4.1 Low-Emitting Materials - Adhesive and Sealants: Provide VOC content data for materials used. Data typically available in manufacturer spec or MSDS. Comply with VOC limits from Division 1 Section "Sustainable Design Requirements". Include LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".

B. Shop Drawings: Submit the following:

1. Floor plans indicating location of each graphic.

2. Elevations of each graphic showing mounting heights, graphic dimensions and locating distances. Show all existing and new wall-mounted items such as fire hose and fire hydrant cabinets, plaques and signage, electrical outlets and switches, access panels, etc. Indicate the items that will temporarily be removed and reinstalled after application of graphic. Callout the items that will remain in place and indicate how the graphic will be placed around them.

3. Provide isometric drawings for graphics designed over two or more adjacent surfaces.

C. Graphic:

1. Color corrected graphics utilizing Photoshop or similar program, and incorporating any changes required from site verification. Prints shall be a minimum of 11”X17” high quality proofing paper capable of accurately representing the final color print. Prints shall include actual pantone numbers and colors of each color indicated next to the graphic.

3. Upon final approval of the graphics, submit one copy of each file on a CD. Files shall be submitted in .eps, ai, pdf, or jpeg. Include the original wet signed color corrected 11x17 print proof.

D. Product Data:

1. Product data for vinyl film, overlay film and inks.

2. Installation and maintenance instructions, including removal of graffiti.

3. Submit MSDS sheets for adhesives, sealants, adhesives, primers, paints and cleaning agents used on the application of the films.

E. Certifications: Submit certification attesting graphic and overlay films are certified as class A per ASTM E84, ANSI/UL 723, or ANSI/NFPA 255.

F. Samples: Submit a three feet by three feet sample illustrating colors of graphic, and materials used.

G. Installation instructions: Manufacturer's installation instructions and instructions for care and removal of graffiti.

H. Documentation: Submit documentation stating compliance to the qualifications and certifications indicated on Article 1.02, Quality Assurance.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site, protect from damage and handle in accordance with manufacturer's instructions.

B. Product shall not be stored at the site. Product shall be delivered immediately prior to installation.

1.05 WARRANTY

A. Film manufacturer shall provide a 5 year warranty against manufacturing defects, premature failure, excessive dimensional change and loss of adhesion for interior applications and a three year warranty for exterior applications.

B. Graphic Fabricator and Installer shall provide a 5 year fabrication and installation warranty against product failure, adhesion and fading for interior applications and a three year warranty for exterior applications.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Products: Products of following manufacturers form basis for design and quality intended.

1. Graphic Film: For interior and exterior applications and for smooth and rough surfaces:

    a. 3M Commercial Graphics, Scotchcal IJ 8624.

    b. Avery Dennison SF MPI 6121.

    c. MACtac.

    d. Equal.

2. Overlay Film: For interior and exterior applications and for smooth and rough surfaces:

    a. 3M Commercial Graphics, Scotchcal IJ 8524.

    b. Avery Dennison.

    c. MACtac.

    d. Equal.

3. Inks:

    a. HP-LX881 latex ink.

    b. Equal.

B. Graphic Fabricators and Installers:

1. CR&A Custom.

2. AAA Flag & Banner Manufacturing Co.

3. Equal.

2.02 VINYL PRODUCTS

A. Graphic Film:

1. Soft white gloss, 2mil thick minimum without adhesive, highly conformable vinyl film designed for solvent based ink jet printer. Graphic film shall be coated on one side with an opaque acrylic or gray pigmented pressure sensitive adhesive, supplied with a release liner.

2. Graphic film shall be designed for direct application onto moderately textured exterior and interior walls, including concrete block, brick, plaster, tile and drywall.

B. Overlaminating Film:

1. High Performance, UV resistant, anti-graffiti highly conformable overlaminate film, 2 mil thick minimum. Overlaminating film shall be coated on one side with a clear permanent pressure sensitive adhesive, supplied with a release liner.

C. General:

1. Product shall be of recent production runs, no older than two months. Store and handle, before and after printing per manufacturer's recommendations.

2. Product shall meet Class A I flame spread rating requirement of 0-25, smoke 0-400, based upon ASTM E-84, ANSI/UL 723, or ANSI/NFPA 255.

3. Product shall use the highest quality, UV and chemical resistant inks in the manufacture of the graphics. Inks shall be Original Equipment Manufacturer (OEM) products and completely compatible with the type and manufacture of the vinyl product, and shall conform to manufacturer's requirements.

4. Product shall adhere permanently (versus repositionable) to substrates to which they are to be applied such as, but not limited to: stucco, uneven, curved or molded surfaces, plaster, masonry, wood, concrete, etc.

2.03 FABRICATION

A. Owner will provide artwork for graphics in .eps or .ai format. In the event that artwork is not available in eps or .ai format, allow for retracing of graphics.

B. Make any corrections required for color and image fit to existing conditions.

C. Prior to fabrication, confirm text, font, size, etc. with OAR and make required corrections or changes.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Perform site verification and measure locations for the graphics. Make any adjustments required for proper installation.

B. Examine substrates for compliance with requirements for non-porous, smooth surface and other conditions affecting the performance of work of this section. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. Proceeding with installation means installer acceptance that existing substrate and conditions are prepared and ready for product installation.

3.02 WALL PREPARATION

A. Comply with Manufacturer's requirements for surface preparation.

B. Repair wall damages, such as holes, loose joints, chipped or peeling paint, remove nails and staples, etc. and return wall to acceptable surface condition to receive graphic.

C. Clean substrate of substances that can impair the product bond, such as oil, grease, dirt, dust, etc., utilizing approved cleaning products.

D. Prime and paint wall per Division 9 Section "Painting" with semi-gloss top coat. Do not use matte paint or paint with silicone, graffiti resistant or texturizing additives. Allow the final coat of paint to dry for at least five days prior to installing the graphic.

E. Perform adhesion test at each wall location to which a graphic will be applied.

F. Temporarily remove wall applied items for the installation of wall graphic. Reinstall removed items after wall graphic has been applied.

3.03 APPLICATION

A. General:

1. Notify Architect when graphics are ready for installation. Arrange for conference at site. Do not proceed with installation until Architect's approval of specific locations and methods of attachment has been obtained.

2. Conform to Manufacturer's recommended installation requirements.

3. If specifications conflict with Manufacturer's recommended installation requirements, the more stringent requirement shall prevail. Specifications shall not cause void to any warranty or guarantee of product or installation.

4. Install substrates with no gaps or overlaps. Installation shall be smooth, wrinkle, bubble, and/or crease free.

5. Confirm surfaces are cleaned within 24 hours prior to applying graphic.

6. Use a DRY application method only.

7. Perform adhesion testing recommended by film manufacturer on the wall of each location in which a graphic will be applied.

B. Smooth Indoor Walls:

1. Lay the graphic image side down on a flat clean surface. If graphic orientation is vertical, pull back about six inches of the liner from the top of graphic. If graphic is orientation is horizontal, pull back about six inches of the liner along one side. Crease the liner.

2. Follow manufacturer's positioning and application technique recommended by manufacturer.

3. Apply the graphic using a stiff nylon brush, moving the brush in a straight line (non-arcing), with firm, overlapping brush strokes. Re-brush all edges after applying the graphic with small circular movements to ensure good adhesion.

C. Textured Walls:

1. Wash the wall with cleaning solution recommended by installer. Avoid soaps or preparations that contain waxes and oils since they impair graphic adhesion. Dry thoroughly.

2. Concrete block walls: Power wash or hand wash with a stiff brush and a detergent cleaner followed by clean water rinse to remove grease. Allow wall to dry thoroughly before applying the graphic. Clean loose mortar with a stiff bristled brush. Brush the substrate lightly immediately prior to graphic application.

3. Follow manufacturer's positioning and application technique recommended by manufacturer.

4. Remove part of the liner and lightly tack the film to the substrate and use roller to roll on the film without heat. Always work toward and open edge through which the trapper air can escape.

5. Direct the heat gun toward the top corner of the graphic, heat a two inch wide band until warm. With the roller closely following the heat gun, move continuously and completely past the outer open edge of the graphic. Overlap the previous roller pass by about 70 percent. Continue working down the graphic.

6. Remove air bubbles by use of an air release tool, do not use knifes. Poke a hole near one end and push out the air. Rework the area with the heat gun and roller to conform the film to the texture.

D. To avoid an exposed edge, which are prone to picking and other damage, trim graphic 1/4 inch maximum from inner or outer wall corners.

E. Finish the graphic by working the brush or manufacturer's approved application tools around the entire outer three inches of the graphic.

F. Graphic installation shall smoothly conform to surface applied, including any curved, mitered, detailed or angled surfaces. Verify cutout locations where wall items were removed, so the flanges of the wall items will cover the film.

G. Use only heat activated vinyl products. Product shall conform to substrate upon application of heat, without compromising final image, and shall have heat activated adhesive substrate. Utilize manufacturer's approved application methods and recommended tools for applying vinyl and overlays.

H. Upon completion of wall graphic application, reinstall wall items that were temporarily removed.

3.04 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.05 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 102113 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes solid-polymer units as follows:
   1. Toilet Enclosures.

B. Related Sections include the following:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 10 "Toilet and Bath Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories.

1.2 PERFORMANCE REQUIREMENTS

A. Accessible Toilet Compartments:
   1. Wheelchair accessible compartment shall comply with CBC Section 11B-604.8.1.
   2. Toe clearance for at least one side partition of a wheelchair accessible compartment shall comply with CBC Section and Figure 11B-604.8.1.4. It shall be 9" high minimum above the finish floor and 6" deep minimum beyond the compartment side face of the partition, exclusive of partition support members. It shall be 12" high minimum above the finish floor for children's use. Partition components at toe clearances shall be smooth without sharp edges or abrasive surfaces. Toe clearance at the side partition is not required in a compartment greater than 66" wide.
   3. An ambulatory accessible compartment shall be provided where there are six or more toilet compartments, or where the combination of urinals and water closets totals six or more per CBC Section 11B-213.3.1. Such compartment shall comply with CBC Section 11B-604.8.2.
   4. Door and door hardware for accessible compartments shall be self-closing and shall comply with CBC Section 11B-404 except that pull-side clearance for ambulatory accessible compartments shall be minimum 44" clear, rather than 60". CBC Figure 11B-604.8.2.
   5. A door pull complying with CBC Section 11B-404.2.7 shall be placed on both sides of the door near the latch.
   6. Ambulatory accessible toilet compartment doors shall not swing into clear floor space or clearance required for any fixtures or into the minimum required compartment area per 11B-604.8.2.2.

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.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content, and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".
2. Product Data for Credit MR 5: For products having regional content, documentation indicating location and distance from project of material manufacturer and extraction, with cost and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".

C. Shop Drawings: 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.

D. Samples for Initial Selection: For each type of unit indicated.

E. Samples for Verification: Of each type of color and finish required for units, prepared on 6-inch-square Samples of same thickness and material indicated for Work.

1.4 QUALITY ASSURANCE

A. Reference Standards:
1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
6. 2016 California Energy Code, Part 6, Title 24 CBSC.
7. 2016 California Historical Code, Part 8, Title 24 CBSC.
8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
15. NFPA 20 - Stationary Pumps, 2016 Edition.
16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication and indicate measurements on Shop Drawings.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating toilet compartments without field measurements. Coordinate wall, floor, ceilings, and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of toilet compartments that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 15 year.

B. Installer Warranty: 2 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Solid-Polymer Units: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
   1. Hiny Hiders – Scranton/Santana/Comtec. (Basis of Design)
   2. Bradley.
   3. Global Materials.
   4. Ampco.
   5. Or equal.

2.2 SOLID-POLYMER UNITS

A. Materials:
   1. Doors, panels and pilasters to be 1 inch thick constructed from High Density Polyethylene (HDPE) resins. Partitions to be fabricated from polymer resins compounded under high pressure, forming a single component which is waterproof, nonabsorbent and has a self-lubricating surface that resists marks from pens, pencils, markers and other writing instruments. All plastic components shall be covered with a protective plastic coating.
   2. Head rails: Heavy-duty extruded aluminum (6463 – T5 alloy) with anti-grip design. The head rail is to have a clear anodized finish. Fasten to head rail bracket with stainless steel tamper resistant torx head sex bolts and fasten to the pilasters with stainless steel tamper resistant torx head screws.

B. Construction:
   1. Doors and panels to be 55-inch-high and mounted 14 inches above finished floor

2. Pilasters to be 82-inch-high and fastened into 3 inch high plastic (one piece molded HDPE) pilaster shoe with stainless steel tamper resistant torx head sex bolt.
3. All bottom edges to include the optional heat sink.

C. Hardware:
1. Hinges: 8-inch-long, heavy-duty extruded aluminum (6463 – T5 alloy) with bright dip anodized finish with wrap-around flanges, through bolted to doors and pilasters with stainless steel, torx head sex bolts.
2. Door Strike/Keeper: 6 inch long, heavy-duty extruded aluminum (6463 – T5 alloy) with bright dip anodized finish and screwed to the pilaster with stainless steel, tamper resistant torx head sex bolts. Bumper is to be extruded black vinyl.
3. Latch and Latch Housing: heavy-duty extruded aluminum (6463 – T5 alloy). Latch housing to have bright dip anodized finish and the slide bolt and button are to have black anodized finish.
4. Coat Hook and Bumper: Each door is to be supplied with one coat hook/bumper and a pull made of chrome plated zamak. Accessible doors shall be supplied with a second pull and out swings with one door stop made of chrome plated zamak.
5. Wall Brackets: 54 inch continuous extruded PVC plastic. Fasten with stainless steel tamper resistant torx head sex bolts.
6. Head rail Brackets: 20-gauge stainless steel with satin finish. Fasten to wall with stainless steel tamper resistant torx head screws.

2.3 FINISHES

A. Solid, high-density polyethylene:
1. Color: As selected by Architect from manufacturer's full range.

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. Attach continuous wall brackets securely to walls using stainless steel fasteners spaced maximum 12 inches on center.
3. Attach panels and pilasters to continuous brackets with one-way sex bolts.

B. Overhead-Braced and Floor-Anchored Units: Secure pilasters to floor and level, plumb, and tighten. Secure continuous head rail to each pilaster with not less 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. Wall-Hung Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb and to resist lateral impact.

3.2 ERECTION TOLERANCES

A. Maximum variation from true position: 1/4 inch. Clearance at vertical edges of doors shall be uniform top to bottom and shall not exceed 1/4 inch.

B. Maximum variation from plumb: 1/8 inch.

3.3 ADJUSTING

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

END OF SECTION 102113

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SECTION 102123 - PRIVACY CURTAIN DIVIDER

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Curtain tracks and curtain carriers.
   2. Curtains.

1.2 PERFORMANCE REQUIREMENTS

A. Curtains: Provide curtain fabrics with the following characteristics:
   1. Fabrics are launderable to a temperature of not less than 160 deg F.
   2. Fabrics are flame resistant and are identical to those that have passed NFPA 701 when tested by a testing and inspecting agency acceptable to authorities having jurisdiction.
      a. Identify fabrics with appropriate markings of applicable testing and inspecting agency.

1.3 SUBMITTALS

A. Product Data: Include durability, laundry temperature limits, fade resistance, and fire-test-response characteristics for each type of curtain fabric indicated.
   1. Include data on each type of applied curtain treatment.

B. Shop Drawings: Show layout and types of cubicles, sizes of curtains, number of carriers, anchorage details, and conditions requiring accessories. Indicate dimensions taken from field measurements.
   1. Include details on blocking above ceiling.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which suspension systems will be attached.
   3. Items penetrating finished ceiling, including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.

D. Samples for Initial Selection: For each type of curtain material indicated.

E. Samples for Verification: For each type of product required, prepared on Samples of size indicated below.

1. Curtain Fabric: 12-inch- square swatch or larger as required to show complete pattern repeat, from dye lot used for the Work, with specified treatments applied. Mark top and face of material.
2. Mesh Top: Not less than 4 inches square.
3. Curtain Track: Not less than 4 inches long.
4. Curtain Carrier: Full-size unit.

F. Curtain and Track Schedule: Use same designations indicated on Drawings.

G. Manufacturer Certificates: Signed by manufacturers certifying that products comply with requirements.

H. Operation and Maintenance Data: For curtains, track, and hardware to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Reference Standards:
1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
6. 2016 California Energy Code, Part 6, Title 24 CBSC.
7. 2016 California Historical Code, Part 8, Title 24 CBSC.
8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
15. NFPA 20 - Stationary Pumps, 2016 Edition.
16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not install cubicles until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cubicle curtains and tracks that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 1 year.

B. Installer Warranty: 2 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Curtain Tracks:
   1. C/S Cubicle Curtains, a Division of Construction Specialties, Inc. (Basis of Design)
   1. InPro Corporation.
   2. Salsbury Industries.
   3. Silent Gliss USA Inc.
   4. Covoc Corp.
   5. Or equal.

B. Curtains:
   1. C/S Cubicle Curtains, a Division of Construction Specialties, Inc. (Basis of Design)
   2. InPro Corporation.
   3. Salsbury Industries.
   4. KoSa; Avora FR.
   5. Trevira, R-M Schulz Consulting, Inc.; Trevira CS.
   6. Covoc Corp.
   7. Or equal.

2.2 CURTAIN TRACKS

A. Product: Model #6062N by C/S Cubicle Curtains or equal.
   1. Description: Surface-mounted tracks of heavy extruded aluminum alloy 6063-T4, 1 3/8" x 3/4", slotted to receive roller carriers, complete with accessories and components required for complete and secure installations including splices, end caps and corner bends.
   2. Corner Bends: Corner bends up to 36" radius are to be fabricated in one continuous "L" shape. Radiuses above 36" to be continuous or spliced based on room condition.
   3. Finish:
      a. Clear anodized aluminum.

4. Carriers:
   a. Breakaway Carriers: C/S Cubicle Curtains 975P, all nylon breakaway carriers. Carrier to have virgin nylon hook, axle and nylon wheels. Carrier hook is to be designed to break away from axle at 22 pounds of applied pressure. Provide one carrier for each 6" of cubicle curtain width.

2.3 CURTAINS

A. Product: C/S Sure-Check linen fabric curtain by C/S Cubicle Curtains or equal.
   1. Provide loop-ended wand top of want loop at 48 inches AFF Max. per CBC 11B-309.4.
   2. Fabric: Fabric to be vinyl, intrinsically fire retardant, and antimicrobial.
   3. Color: As selected by Architect from manufacturer's full range.
   4. Width: Equal to track (or shower curtain rod) length from which curtain is hung plus 10 percent, but not less than 12 inch.
   5. Length: Equal to floor-to-ceiling (or shower rod-to-floor) height minus 2 inch from finished ceiling at top and 1 inch above finished floor.
   6. Top Hem: Not less than 1 inch and not more than 1-1/2 inch wide, triple thickness, reinforced with integral web and double stitched.
      a. Grommets: 2 piece, rolled-edge, rustproof, nickel-plated brass and spaced not more than 6 inch o.c.
   7. Bottom and Side Hems: Not less than 1 inch wide, reinforced, triple thickness and single stitched.
   8. Seams: Not less than 1/2 inch wide, double turned and double stitched.
   9. Curtain Tieback: At each termination.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of work.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install tracks level and plumb, according to manufacturer's written instructions.

B. Up to 16 feet in length, provide track fabricated from 1 continuous length.
   1. Curtain Track Mounting: Surface.

C. Surface Track Mounting: Fasten surface-mounted tracks at intervals of not less than 24 inches. Fasten support at each splice and tangent point of each corner. Center fasteners in track to ensure unencumbered carrier operation. Attach track to ceiling as follows:
   1. Attach track to suspended ceiling grid with manufacturer's proprietary clip.

D. Suspended Track Mounting: Install track with suspended supports at intervals of not more than 48 inches. Fasten support at each splice and tangent point of each corner. Secure ends of track to wall with flanged fittings or brackets.

E. Track Accessories: Install splices, end caps, connectors, end stops, coupling and joining sleeves, and other accessories as required for a secure and operational installation.

F. Curtain Carriers: Provide curtain carriers adequate for 6-inch spacing along full length of curtain plus an additional carrier.

G. Curtains: Hang curtains on each curtain track.

END OF SECTION 102123

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SECTION 102220 – CUSTOMIZED INTERIOR PREFABRICATED WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior unitized-panel customized prefabricated walls.

B. Related Sections:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 8 Section “Glazing” for additional glazing requirements for glass panels and doors.
   3. Division 26 sections for electrical materials, installation, and connections.

1.2 SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content, and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".
   2. Product Data for Credit MR 5: For products having regional content, documentation indicating location and distance from project of material manufacturer and extraction, with cost and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".
   3. Product Data for Credit IEQ 4.1 Low-Emitting Materials - Adhesive and Sealants: Provide VOC content data for materials used. Data typically available in manufacturer spec or MSDS. Comply with VOC limits from Division 1 Section "Sustainable Design Requirements". Include LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".

C. Shop Drawings: Customized Prefabricated Walls
   1. Include plans, elevations, sections, connection details, and attachment details to other work.
   2. Include critical field measurements for [standard] modular installation, including finished width and height of partitions.
   3. Provide structural analysis data for installed products indicated to comply with design loads, signed and sealed by licensed professional engineer responsible for their preparation.

D. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard sizes 6 inches square in size.

E. Samples for Initial Selection: For each type of exposed finish.

1. Include Samples of hardware and accessories involving color or finish selection.

F. Samples for Verification: For each type of the following products:
1. Face-Panel Finish: Manufacturer's standard-size unit, but not less than 6 inches square.
2. Linear Trim: 12-inch long Samples.
3. Door Finish: Manufacturer's standard-size unit, but not less than 3 inches square.
4. Glazing: Manufacturer's standard-size unit, but not less than 3 inches square.
5. Hardware and Accessories: Whole units.

G. Coordination Drawings:
1. Provide all final engineered drawings relevant to material inclusions within, or connections to the prefabricated wall product.
2. Provide architectural plans locating prefabricated wall products, including wall finishes and construction of surfaces with which the prefabricated wall system interfaces with or connects to.
3. Provide reflected ceiling plans, drawn to scale, on which penetrations and ceiling mounted items are shown and coordinated with demountable partitions.
4. Electrical Drawings: Coordinate electrical provisions to be included in prefabricated partitions with final circuited electrical engineering drawings and schedules.

H. Product Certificates: For each type of prefabricated partition.

I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of prefabricated partition.

J. Evaluation/Certification Reports:
1. LARR (Los Angeles Research Report) – 25604, based on ICC ESR (Evaluation Service Report).
2. ESR-1947 (reissued 2007): Provide evidence of compliance with structural performance requirements and the building code.
3. Limited Production Certification (LPC), Report No. LPCE 75090-1: Provide evidence of compliance with CAN/CSA-C22.2 No. 203 and UL 1286 for modular wiring systems for office furniture.

K. Maintenance Data: For prefabricated partitions to include in maintenance manuals.

1.3 QUALITY ASSURANCE

A. Reference Standards:
1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
6. 2016 California Energy Code, Part 6, Title 24 CBSC.
7. 2016 California Historical Code, Part 8, Title 24 CBSC.

8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
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13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
15. NFPA 20 - Stationary Pumps, 2016 Edition.
16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
   1. Build mockups for customized prefabricated walls including accessories.
      a. Size: 48 inches by 48 inches by full height.
      b. Each type of exposed construction, corner, door and frame, glass and frame and accessory panel.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Pre-installation Conference: Conduct conference at Project site.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of prefabricated walls that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of prefabricated walls.
   2. Warranty Period: Two years.

B. Installer's Warranty: 2 years.

1.5 FIELD CONDITIONS

A. Finished Spaces: Do not deliver or install prefabricated partitions until finishes in spaces to receive them are complete, including suspended ceilings, floors, carpeting, and painting.

B. Field Measurements: Indicate measurements on Shop Drawings.

1.6 EXTRA STOCK

A. Furnish extra materials, from same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Partition Components: Furnish a quantity of two percent of the amount installed, but no fewer than 2 units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Customized Interior Prefabricated Walls:
   1. DIRTT Environmental Solutions; Solid Walls, Glass Walls & Doors. (Basis of Design)
   2. Haworth, Inc.
   3. Herman Miller Wall Alliance.
   4. Or equal.

2.2 SPECIAL "OR EQUAL" DSA PROCESS

A. Basis of Design product has been approved by DSA. Contractor is solely responsible for obtaining all necessary approvals and all costs associated with obtaining the approval of DSA including all Architectural and Engineering fees for coordinating with DSA for "or equal" product proposed. Do not commence installation until all approvals have been obtained.

B. Submittals:
   1. Submit initial deferred approval submittal to Architect within 35 calendar days from the date of issuance of Notice to Proceed, and before any materials are delivered to the job site. Contractor is solely responsible for obtaining all necessary approvals. Do not commence installation of any approval item until all approvals have been obtained.
   2. Product Data: Product data: Submit manufacturer's specifications and certified test reports made by an independent testing organization for each type and class of material to show compliance with code requirements and gain approval of DSA.
   3. Shop Drawings: Submit complete shop drawings including dimensioned plans, elevations, and all details of typical sections and connections. Shop drawings shall show design loads and all details of the installation. Title sheet of shop drawings shall list testing requirements and shall state that licensed engineer shall review and certify the completed installation is in accordance with the approved shop drawings. Shop drawings shall be stamped, dated and signed by professional engineer licensed in the State of California as evidence of his or her responsibility for the work.
   4. Shop drawings:
      a. Format: 30" x 42" sheet format with border and title block identifying, at a minimum, the project name, project number, project location, date, contractor and structural engineer of record.
      b. 1 set of reproducible shop drawings each submittal review.
      c. 1 set of reproducible shop drawings for each plan check review.
      d. 1 set of reproducible shop drawings approved by DSA.

5. Calculations: Submit calculations prepared by a professional engineer licensed in the State of California. Engineer shall sign, date and stamp calculations as evidence of his or her responsibility for the work.
6. Submittals shall be approved first by the Architect, then by the DSA.

2.3 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing 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.

B. Structural Performance: Provide customized prefabricated walls capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Load-Bearing Capacity: Not less than 300-lb concentrated and 2.3-lb/linear inch distributed proof load when tested according to ANSI / BIFMA X 5.6.
2. Transverse-Load Capacity: Lateral deflection of not more than 1/120 of the overall span when tested under a uniformly distributed load of 5 lb/sq. ft. according to ASTM E 72.

C. Acoustical Performance: Where acoustical rating is indicated, provide prefabricated-partition assembly tested by a qualified testing agency for sound transmission loss performance according to ASTM E 90, calculated according to ASTM E 413, and rated for not less than the STC value indicated.
1. Testing to be done by a qualified independent testing agency.

D. Electrical Components, Devices, and Accessories: Listed and labelled in accordance with NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

2.4 UNITIZED-PANEL CUSTOMIZED PREFABRICATED WALLS

A. General: Unitized, prefabricated-partition assembly and components that are the standard products of manufacturer.

B. Acoustical Rating: STC 35.

C. Unitized Solid Panels: Manufacturer's standard gypsum board or particleboard.
1. Aluminum Framing: Aluminum extrusions, 6063-T54 or 6061-T6 aluminum alloy.
2. Face Mounted Tile Attachment: Provide unitized frame assembly to accept face mounted tiles with orientation and module increments as specified.
3. Frame Accessibility: Provide up to 3 inches clear wall cavity for distribution of utilities accessible from either side of wall by removable face panels.
4. Face Panels, MDF Chroma Coat:
   a. Thickness: 1/2 inch.
   b. Width and height: As indicated on drawings.
   c. Paint Finish: Factory-applied paint finish as follows:
      1) Series: Standard.
      2) Color: Match adjacent as approved by Architect.

5. Electrical, Communications, and Security System Requirements: Provide for installation of electrical, communications, and security system items arranged so that wiring can be readily removed and replaced.
   a. Conduit: Provide option for metal conduit in cavity of prefabricated partitions, from outlet and device boxes to top or bottom of prefabricated partitions to permit wiring installation and connections.
   b. Boxes: Provide outlet and device boxes in cavity of prefabricated partitions for all outlets and devices indicated. Provide metal junction and pull boxes where indicated or required.
   c. Electrical, Communications, and Security System Components: Provide all cutouts and reinforcements required for prefabricated partitions to accept electrical, communications, and security system components.

D. Glass Panels:
   1. Aluminum Glazing Framing: Aluminum extrusions, 6063-T54 or 6061-T6 aluminum alloy.
   2. Glazing: Glazing to be fully tempered, safety glass. Minimum thickness per lite 1/4 inch. Glass type indicated complying with Division 8 Section "Glazing".
      a. Glass: Tempered.
         1) Clear.
         2) Frosted.

E. Frame Bases:
   1. Provide frame bases with provisions for height adjustment to accommodate floor slab variances.
   2. Provide a leveling mechanism for making fine adjustment in height over adjustment range of the product.

F. Connections and Supports: Manufacturer's standard connections and supports that connect and release from floor and ceiling without damage using carpet grippers and ceiling track clips, with exception of the following conditions: bulkhead (drywall ceiling), seismic conditions, electrical or service feeds, physical connections to base building (where required).

G. Panel Joint Closure: Manufacturer's standard, capable of closing up to a 1 inch gap between demountable partitions and base building elements.

H. Trim: Continuous and modular, factory-finished, snap-on type; adjustable for variations in floor and ceiling levels.
   1. Base Trim Profiles: Recessed; removable to access leveling mechanisms.
   2. Ceiling Trim Profile: Recessed; adjustable to accommodate up to a 1/2 inch gap between demountable partitions and base building elements.
   3. Wall Trim Profile: Recessed; adjustable to accommodate up to a 1/2 inch up to 1 inch gap between demountable partitions and base building elements.
   4. Panel to Panel Profile: As detailed.
   5. Colors: As selected by Architect from manufacturer's full range.

2.5 SLIDING DOORS

A. Flush Wood Doors: Manufacturer's standard solid core door.
   1. Door Thickness: 1-11/16 inches thick.

2. Pressed high density fiberboard skin on both sides of door on particleboard core.
3. Edging: Solid edging, veneer finish.
4. Finish: Match flush wood doors specified in Division 8 Section "Flush Wood Doors" as approved by Architect.

B. Framed Glass Doors: Manufacturers standard 6" thick stile framed glass door.

1. Units shall include self-supporting header and track, jambs, sliding door, and be completely trackless at the floor between jambs.
2. All sliding doors shall be non-handed in that on-site adjustment can configure door to slide in opposite direction with no additional hardware required.
3. Sliding doors shall contain ADA compliant (single action motion) locking hardware that can be keyed to building / end-user standards.
4. Cylinder/Lever Backset – Available in 70mm (2-3/4") and 101.6mm (4".) Lock body available in either left or right hand slide, with either single or double point security.
5. Lever Style – Mortise case design to mount Schlage L-Series levers. Finish spec based on lever selection. 626 Schlage L-Series 03 Lever standard, unless otherwise specified.
6. Thumbturn – Available in either standard or an extended paddle turn for easier accessibility. 626 finish unless otherwise specified.
7. Lockbolt – 2013mm (8") hexagonal 9.5mm (3/8") hardened steel bolt. Throw extension is 16mm (5/8"), into adjustable stoppers/slowdown strike fully concealed into roller track assembly.
8. Faceplate – 298mm (11-3/4") x 31mm (1-1/4") x 3mm (1/8".)
9. Glazing: Safety glass, fully tempered, 1/4 inch thick, clear or custom finish as indicated.

2.6 DOOR TRACK ASSEMBLY

A. Height: 1-9⁄16".

B. Track Depth: 1-7⁄8".

C. Track Width (standard): 73-1⁄2" includes end caps. Adjusts to suit parametric widths.

D. Pneumatic Slow Down Mechanism Attached to door Installation Includes: Unique hanger design requiring no fasteners to the DIRTT frame system or drywall.

2.7 DOOR FRAMES

A. Sliding Door Frames: Manufacturer's standard aluminum frame single door, reversible, factory milled to receive hardware, for 1-11/16 inch doors. Door frames capable of reconfiguration without part replacement or damage to wall components.
   1. Door Module Size: As indicated on Drawings.
   2. Configuration: Header, jambs and pivot hardware. Single door frame width not to exceed 44 inch wide module.
   3. Actual door width is equal to module width less 2 inches.
   4. Hardware Reinforcement: Milled, reinforce, drill and tap frames at factory to receive specified hardware in accordance with the contract hardware schedule and templates.
   5. Frame Height: Jambs shipped over length (height) by 2 inches, for field cutting to suit opening height for proper alignment with adjacent frames.
   6. Frame Preparation: Factory installed top pivot plate.
   7. Extrusion Profile: Rectilinear profile to match any adjacent unitized glass frames.
   8. Seals: Manufacturer's standard.

2.8 ACCESSORIES

A. Accessories and Brackets:
   1. Manufacturer's brackets, supports and accessories for complete installation of system's furniture components, architectural millwork, audio visual equipment, and paper accessories.
   2. Provide bracket design to enable other system furniture to mount to prefabricated partition, on or off module.

2.9 FABRICATION

A. Customized Prefabricated Walls:
   1. Factory-Assembled frames with 1 inch insulation, base track and levelers; face mounted tiles installed to frames on site.
   2. Fabricate panels for installation with concealed fastening devices and pressure-fit components that will not damage ceiling or floor covering exceptions.
   3. Fabricate panels with continuous light-and-sound seals at floor, ceiling, and other locations where panels abut fixed construction.
   4. Factory glaze panels to the greatest extent possible.

B. Components:
   1. Fabricate components for installation with concealed fastening devices and pressure-fit members that will not damage ceiling or floor coverings. Exceptions: Drywall ceiling, seismic applications and doors against base building require screw holes in base building for proper fastening.
   2. Fabricate for installation with continuous seals at floor and other locations where partition assemblies abut fixed construction and for installation of sound attenuation insulation in partition cavities.

C. Electrical, Communications, and Security System Components: Fabricate prefabricated partitions to accept electrical, communications, and security systems components.

2.10 WOOD MATERIALS

A. Particleboard: Panels complying with ANSI A208.1, Grade M-2.
   1. Made with binder containing no urea formaldehyde.
   2. Panels comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
   3. Fire-retardant panels made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less when tested according to ASTM E 84.

B. Wood Veneer: Genuine wood veneer; clear, vertical grain, straight, and kiln dried; of wood species indicated, laminated to panel substrate with moisture-resistant adhesive.
   1. Maple rotary cut: Book match leaves.

2.11 GENERAL FINISH REQUIREMENTS

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

B. 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.

2.12 FINISHES

A. Protect finishes on exposed surfaces from damage during shipping.

B. Appearance of Finished Work:
   1. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved samples.
   2. Noticeable variations in the same piece are not acceptable.
   3. 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.

C. Aluminum Finishes:
   1. Factory Clear Anodic Finish: AAMA 611, Class II, 0.010 mm or thicker clear anodic coating over a non-specular as fabricated mechanical finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install customized prefabricated partitions after other finishing operations have been completed.
   1. Install customized prefabricated partition systems to manufacturer's written instructions.

2. Install partitions rigid, level, plumb, and aligned. Install seals at connections with floors, ceilings, fixed walls, and abutting surfaces to prevent light and sound transmission.
3. Apply finished face mounted tiles to framing.
4. Install continuous insulation in base trim cavity.
5. Install seals to prevent light and sound transmission at connections to floors, ceilings, fixed walls, and abutting surfaces.
6. Install doors and frames, glazing, and glazing frame assemblies securely anchored to prefabricated partitions and with doors aligned and fitted.
7. Broken, cracked, chipped, deformed, or unmatched panels and components are not acceptable.
8. Except for filler panels scribed to fixed walls or columns, do not modify manufacturer's standard components.

B. Suspended-Ceiling System: Do not alter suspended-ceiling system or when indicated make alterations to suspended-ceiling system required by prefabricated partition installation or to gain access to electrical or communication systems without affecting the structural integrity of suspended-ceiling system. Make alterations so they are not noticeable after panel installation.

C. Doors and Frames: Install door-and-frame and glazing-and-glazing-frame assemblies securely anchored to partitions and with doors aligned and fitted. Install and adjust door hardware for proper operation.

3.2 ERECTION TOLERANCES

A. Install each prefabricated partition so surfaces vary not more than 1/8 inch from the plane formed by the faces of adjacent partitions.

3.3 ADJUSTING

A. Inspect installation, correct misalignments, and tighten loose connections.

B. Adjust doors to operate smoothly and easily, without binding or warping.

C. Check and readjust operating hardware. Verify that latches and locks engage accurately and securely without forcing or binding; lubricate as recommended by manufacturer.

D. Clean soiled surfaces to remove dirt, fingerprints, adhesives, and other foreign materials according to manufacturer's written instructions.

E. Remove and replace defaced or damaged components.

F. Remove and replace components that are wet, moisture damaged, or mold damaged.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain customized prefabricated partitions.

END OF SECTION 102220

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SECTION 102226 - OPERABLE PANEL PARTITIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Automatic vertically folding acoustical partition.

B. Related Sections include the following:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 9 Section "Gypsum Board" for sound barrier construction above the ceiling at track.
   3. Division 26 Sections for electrical service and connections for motor operators, controls, and limit switches; and for system disconnect switches.

1.2 SUBMITTALS

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

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content, and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".
   2. Product Data for Credit MR 5: For products having regional content, documentation indicating location and distance from project of material manufacturer and extraction, with cost and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".
   3. Product Data for Credit IEQ 4.1 Low-Emitting Materials - Adhesive and Sealants: Provide VOC content data for materials used. Data typically available in manufacturer spec or MSDS. Comply with VOC limits from Division 1 Section "Sustainable Design Requirements". Include LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".

C. Shop Drawings: Submit shop drawings showing complete layout of operable wall system based on field verified dimensions. The drawings shall include dimensional relationship to adjoining work. Include details indicating materials, finishes, tolerances, and methods of attachment to building steel and electrical requirements.

D. Submit certified test reports evidencing compliance to acoustical STC requirements as specified.

E. Samples for Initial Selection: For each type of finish, covering, or facing indicated.
   1. Include similar Samples of accessories involving color selection.

F. Samples for Verification: For each type of finish, covering, or facing indicated, prepared on Samples of size indicated below.
   1. Fabric: Full width by not less than 36-inch- long section of fabric from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat.
   2. Panel Facing Material: Manufacturer's standard-size unit, not less than 3 inches square.
   3. Panel Edge Material: Not less than 3 inches long.
   4. Chair Rail: Manufacturer's standard-size unit, 6 inches long.
   5. Hardware: Manufacturer's standard exposed door-operating device.

G. Maintenance Data: For operable panel partitions to include in maintenance manuals.
   1. Panel finish facings and finishes for exposed trim and accessories. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.
   2. Seals, hardware, track, carriers, and other operating components.
   3. For electric operator.

H. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Reference Standards:
   1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
   2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
   3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
   4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
   5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
   6. 2016 California Energy Code, Part 6, Title 24 CBSC.
   7. 2016 California Historical Code, Part 8, Title 24 CBSC.
   8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
   9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
   10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
   11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
   12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
   13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
   14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
   15. NFPA 20 - Stationary Pumps, 2016 Edition.
   16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
   17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
   18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
   19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
   20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
   21. Americans with Disabilities Act (ADA), Title II.

B. Installer Qualifications: Installed only by qualified representatives and/or installers and/or distributors of the manufacturer, according to the manufacturers written instructions.

C. Fire-Test-Response Characteristics: Provide operable panel partitions with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 450 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.4 SITE CONDITIONS

A. The floor underneath the operable wall along its axis, shall be flat to within plus or minus 1/4 inch over the entire length of an operable wall. The peak to valley undulation of plus or minus 1/4 inch shall not be closer together than 24 inches and a peak to valley undulation of plus or minus 1/8 inch shall not be closer than 12 inches.

B. Support steel above the operable wall along its axis shall be parallel to the floor within plus or minus 1/2 inch for the entire length of the operable wall. This includes loaded deflection. The beam must also be parallel to the centre line of the wall within plus or minus 1/8 inch, left to right.

C. The fixed walls at either end of the operable wall shall be within 0 to 1/4 inch, from plumb vertical.

D. The fixed walls at either end of the operable wall shall be flat to within +0 to 1/4 inch.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of operable panel partitions that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of operable panel partitions.
   2. Warranty Period: Two years.

B. Installer's Warranty: 2 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Operable Panel Partitions: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
   1. Skyfold by Railtech Ltd. (Basis of Design)
      a. Skyfold Classic NR.
   2. Or equal.

2.2 MATERIALS

A. Acoustical Panels:
   1. Acoustical panels, together with all of the sound insulation, shall be made of non-combustible or fire-treated materials.
   2. Acoustical panels shall be fabricated to be as stiff as possible.
   3. Acoustical panels shall be architecturally flat with no bowing, oil canning, warping, waviness or any other surface deformation and discontinuity.
   4. Finish: Vinyl (only for Skyfold Classic NR) as selected by Architect from manufacturers full range.

B. Folding Mechanism:
   1. The hanging, folding and extension mechanism shall be made from structural grade aluminum extrusions and structural shapes.
   2. All wear surfaces, such as bushings, spacers, pins, discs, bearings, and sleeves shall be designed to function quietly and with minimum wear, over the 10,000 cycle design life of the operable wall.
   3. The hangers, which fasten the lifting mechanism to the support steel, shall be fabricated from steel and shall be welded or bolted to the support steel.

C. Lifting Equipment:
   1. The lifting equipment shall be sized properly so that it can open and close the wall effectively over the 10,000 cycle design life of the wall, at the minimum design speed.
   2. The lifting mechanism shall be designed to function as smoothly, quietly and safely as possible.
   3. There shall be a wire rope cable for every set of lifting mechanisms. This cable shall be of 6 x 31 construction aircraft cable and shall be made of galvanized steel. The diameter of the cables shall be sized so that they shall be able to hold the entire weight of the wall, with the appropriate safety factor.
   4. The cable wraps on yoyo drums with 2 safety wraps and multiple layers of cable.
   5. The line shaft, sized to deliver the required torque with minimum deflection, shall support and rotate the cable drums.
   6. Flange bearings shall be used for the drive system, located immediately on both sides of the drum assembly.
   7. The power drive shall be sized to deliver sufficient amount of torque to safely and effectively raise and lower the operable wall over its design life.
   8. The lifting equipment shall use the latest in industry standards in thermal protection, overload protection, quick acting fuses, etc., in order to ensure the safety and reliability of the system.

D. Safety Equipment:
1. The operable wall shall employ an electromagnetic type of brake which shall activate firmly, without hesitation, when power is lost to the system. This brake shall have a minimum retarding torque rating equal to 200% of the power drive full load torque. A manual break release lever is supplied on the motor.
2. The operable wall shall employ a dynamic brake, distinct and separate from the brake specified above, in order to lower the wall at a controlled speed of no more than approximately 150% of the normal down speed, in the case of a catastrophic failure in the power train. Alternately, the operable wall shall employ a brake, distinct and separate from the brake specified above, in order to completely halt the downward motion of the wall in the case of a catastrophic failure in the power train.
3. The operable wall shall employ electrical or other limit switches in order to stop the wall at its up and down travel limits.
4. The operable wall shall employ an over torque detector in order to sense a jam in the system and to act as an over travel limit in the up direction should the primary limit switch fail to act. This over torque sensor shall be mechanical, using the motor's torque arm in its over torque detection.
5. The entire length of the bottom edge of the operable wall shall be equipped with a continuous pressure sensing strip which shall cut power to the lifting equipment and shall activate the brake, if the sensing edge comes in firm contact with an object, before the wall is in the full down (closed) position. The power shall remain cut to the lifting equipment until the key switch has been released or the direction of the wall has been reversed and the obstruction is removed.

E. Electrical:
1. The operable wall shall be equipped for a three phase power supply to the electrical control box.
2. Standard electrical control box will be NEMA 1.
3. Low voltage wiring (by others). 18 gauge wiring from the switches to the control box.
4. Switches: Two (2) push button switches wired in series with power controlled by a single, three position key switch.

2.3 Fabrication: Factory assemble all components, assemblies and systems into the largest possible assemblies in order to minimize the amount of assembly on site.

2.4 AUTOMATIC VERTICALLY FOLDING ACOUSTICAL PARTITION

A. Acoustical partitions that, when in the down position (closed) are hard, rigid, flat, plumb walls, made of a grid of rectangular acoustical panels, and when are lifted (opened), fold upward (vertically) without the use of any manual labor, in a manner similar to an accordion, into a pocket in the ceiling, between roof joists, or up between built in bulkheads. In the down (closed) position, the wall shall be comprised of two vertical planes of acoustical panels, separated by an acoustical air space.

B. The operable wall shall open and close in a manner similar to an accordion, in that all wall panels fold and unfold at the exact same time, at the exact same rate.

C. There are two types of drive systems available for the operable wall:
1. Compact Drive System:

a. The motor assembly is mounted directly above the centre line of the operable wall. Support steel is only required at one location.
b. Minimum wall length is 10'-7". Used for walls up to the following finished ceiling heights:
   1) Skyfold Classic NR: 34'-2".

D. The operable wall shall be opened and closed using two push button switches wired in series with power controlled by a single, three position key switch. Turning the key from the "off" position shall cause the wall to move in the designated direction "up" or "down" once both push buttons are depressed. When hand pressure is removed, the wall shall immediately stop. The operable wall shall stop in a quick and positive fashion without coasting. As a normal part of the operation, it shall be possible to partially open (or close) the wall, stop it and then reverse the operation. There shall be two (2) switches per operable wall, located on opposite sides of the wall at opposite ends of the wall, wired in series.

E. From a fully open position, the wall shall be able to go through its entire cycle of closing and/or opening without any manual intervention.

F. When the operable wall is being lowered (closed) it shall come automatically to rest once it has reached the fully down (closed) position.

G. When the operable wall is being lifted (opened) it shall come automatically to rest once it has reached the fully up (open) position.

H. The operable wall shall automatically and acoustically seal against the floor without the need for any manual intervention. The floor seals shall leave a joint between the floor and the bottom acoustical panels of not more than approximately 2 inches.

I. The operable wall shall automatically and acoustically seal against the two end walls without the need for any manual intervention. The end seals shall act in such a way as not to come into contact with the end walls while the operable wall is in motion. The end seals shall leave a joint between the acoustical panels and the end walls of no more than approximately 1 inch. Seals that rub or brush against the end walls are not acceptable. Once the wall reaches the full down position, the end seals shall activate automatically. The key switch must be held for the duration of the operation.

J. The operable wall shall automatically and acoustically seal against the ceiling without any manual intervention. The top seals shall leave a joint between the top acoustical panels and the ceiling of the pocket of not more than approximately 2 inches.

K. The operable wall shall open and close at a constant nominal speed of approximately 5 to 10 vertical feet per minute (1.5 to 3 meters per minute).

L. When the operable wall is being lowered (closed), it shall stop if the leading (bottom) edge comes into firm contact with any object between it and the floor. The regular operation of the wall shall resume once the switch has been released and the direction of the wall has been reversed and the obstruction removed.

M. The operable wall shall be visibly flat and rigid in the down (closed) position.

N. There shall be no exposed hinges, brackets, screws, and no part of the mechanical system shall be visible when the operable wall is in the down (closed) position.

O. All of the panel edges shall be right angled, with a minimum radius not more than 1/16 inch.

P. All of the panels shall be rectangular, nominally of the same size, unless requested otherwise by the architect.

Q. Joints between panel, vertical and horizontal, shall be no more than approximately 1/2 inch wide.

R. For operable walls using the Compact Drive System, the operable wall shall stack in the up (open) position into a space no greater than 65 inches wide.

S. The operable wall shall have a stacking height ratio in the range of 1:5 to 1:10, depending on the height of the wall.

T. Each acoustical panel shall be individually removable using only a screw driver. No special tools or equipment shall be required. The removal of a single acoustical panel shall not affect, dislocate or cause the removal of any adjacent panels or other acoustical panels.

U. The operable wall shall be mechanically operable with a few of the acoustical panels removed from one, or both sides of the operable wall.

V. The preceding weights do not include the lifting equipment and the architectural finish on the acoustical panels and are based on 24'-0" long x 14'-1" high partitions.

W. A completely functioning operable wall, tested in full accordance and compliance with ASTM C423 shall achieve a Laboratory Noise Reduction Coefficient (NRC) rating of not less than the following
1. Skyfold Classic NR system: NRC 0.65.

X. The operable wall shall be designed to have a design life of at least 10,000 complete closed to opened to closed cycles.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect the relevant aspects of the site such as the evenness of the floor, walls, structural steel, etc., and ensure that these are within the tolerances specified.

B. Confirm in writing any deviations from these tolerances. Do not proceed until these conditions are made good.

C. Carry out all appropriate field measurements before manufacturing any components or assemblies.

3.2 INSTALLATION

A. Install operable walls in accordance with the manufacturer's printed instructions.

3.3 ADJUSTING AND CLEANING

A. Adjust and fine-tune the operable walls to ensure that all seals are operating and sealing properly and that the walls are in correct and smooth operation.

B. Clean up any dirt, oil, grime, etc., that may have found its way onto the acoustical panels. Leave the wall in a state of architectural cleanliness.

END OF SECTION 102226

SECTION 102600 – WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Corner guards.
   2. Crash rails.

B. Related Sections include the following:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.

1.2 SUBMITTALS

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

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content, and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".
   2. Product Data for Credit MR 5: For products having regional content, documentation indicating location and distance from project of material manufacturer and extraction, with cost and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".

C. Samples for Initial Selection: For each type of impact-resistant wall-protection unit indicated.
   1. Include similar Samples of accent strips and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
   1. Wall Guards: 12 inches long. Include examples of joinery, corners, end caps, top caps, and field splices.

E. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Reference Standards:
   1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
   2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).

3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
6. 2016 California Energy Code, Part 6, Title 24 CBSC.
7. 2016 California Historical Code, Part 8, Title 24 CBSC.
8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
15. NFPA 20 - Stationary Pumps, 2016 Edition.
16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

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

C. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.

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

E. Product Options: Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall-protection units and are based on the specific system indicated.
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.

F. Fire-Test-Response Characteristics: Provide impact-resistant, plastic wall-protection units with surface-burning characteristics as determined by testing identical products per ASTM E 84, NFPA 255, or UL 723 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

1.4 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: 5 years.

B. Installer's Warranty: 2 years.

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.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Impact-Resistant Wall Protection:
1. Construction Specialties (C/S), Inc. (Basis of Design)
2. ProTek Systems Inc.
3. Or equal.

2.2 WALL GUARDS

A. Product: Stainless Steel CO-8 by Construction Specialties (C/S), Inc. or equal:
1. 16 gage, Type #304 alloy with #4 satin finish, shipped with protective strippable coating.
2. Leg length: 2-inch.
3. Bend: 90 degrees.

B. Product: Crash Rail, Model SCR by Construction Specialties or equal.
1. Type: Surface mounted crash rail.
2. Rail to be mounted with 1-1/2 inch wide aluminum clips spaced 16 inches on center.
3. Clips to contain a continuous regrind retainer with flexible cushion.
4. Materials: PVC-Free thermoplastic, extruded material, high impact Acrovyn 3000 with pebblette grain texture, nominal .078 inch thickness. Chemical and stain resistance per ASTM D-1308.
5. Color: As selected by Architect from manufacturer's full range.
6. Regrind Retainer: Recycled PVC-free thermoplastic compound.
7. Fasteners: All fasteners to be non-corrosive and compatible with aluminum retainers.
8. All necessary fasteners to be supplied by the manufacturer.

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 of support fasteners.
   2. For impact-resistant wall-protection units attached with adhesive or foam tape, 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 impact-resistant wall-protection units in locations and at mounting heights indicated on Drawings.
   2. Provide splices, mounting hardware, anchors, and other accessories required for a complete installation.
      a. Provide anchoring devices to withstand imposed loads.
      b. Where splices occur in horizontal runs of more than 20 feet, splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches.
      c. Adjust end and top caps as required to ensure tight seams.

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 102600

SECTION 102813 - TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:
   1. Toilet and bath accessories.

B. Related Sections:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Elements of Sanitary facilities shall be mounted at locations in compliance with CBC Sections 11B-602 through 11B-612.
   2. Grab bars in toilet facilities and bathing facilities shall comply with CBC Section 11B-609.
   3. Grab bars and any wall or other surfaces adjacent to grab bars shall be free of sharp or abrasive elements and shall have rounded edges. The space around the grab bars shall be as follows:
      a. 1-1/2" between the grab bar and the wall.
      b. 1-1/2" minimum between the grab bar and projecting objects below and at the ends.
      c. 12" minimum between the grab bar and projecting objects above.

1.3 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.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content, and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".
   2. Product Data for Credit MR 5: For products having regional content, documentation indicating location and distance from project of material manufacturer and extraction,

with cost and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".

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

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

1.4 QUALITY ASSURANCE

A. Reference Standards:
   1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
   2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
   3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
   4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
   5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
   6. 2016 California Energy Code, Part 6, Title 24 CBSC.
   7. 2016 California Historical Code, Part 8, Title 24 CBSC.
   8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
   9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
   10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
   11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
   12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
   13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
   14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
   15. NFPA 20 - Stationary Pumps, 2016 Edition.
   16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
   17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
   18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
   19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
   20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
   21. Americans with Disabilities Act (ADA), Title II.

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

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.

1.5 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.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace toilet and bath accessories that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: 1 year.

B. Installer's Warranty: 2 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Toilet and Bath Accessories: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
   1. Bobrick Washroom Equipment, Inc. (Basis of Design)
   2. American Specialties, Inc.
   3. Bradley Corporation.
   4. Or equal.

B. Underlavatory Guards: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
   1. IPS Corp. (Basis of Design)
   2. Plumberex Specialty Products, Inc.
   3. TCI Products.
   4. Truebro, Inc.
   5. Or equal.

2.2 MATERIALS

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

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

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

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

E. Fasteners: Screws, bolts, and other devices of same material as accessory unit 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.

2.3 TOILET ACCESSOIRES

A. As indicated on Drawings.

2.4 UNDERLAVATORY GUARDS

A. Product: LAV SHIELD by IPS Corp or equal.
   1. Model: Factory pre-cut for lavatory specified. Provide standard model for field fit applications only when not available.
      a. Model #2018-AS-M, American Standard Muro.
   2. Description: Rigid enclosure is dimensionally engineered to satisfy ADA requirements, design aesthetics and mechanical cooperation. LAV SHIELD conceals electronic faucet components, mixing valves, trap primers and instantaneous water heaters, while allowing wheelchair accessibility under lavatories and eliminating vandalism.
   3. Material Data:
      a. Rigid high-impact, stain-resistant, rigid PVC.
      b. Nominal Wall Thickness: .093".
      c. Finish: Fine haircell.
      d. UV Protection will not fade or discolor.
      e. Durability: Virtually indestructible.
      f. Fasteners: 7 stainless steel screws and wall anchors.
      g. Color: China white.
      h. Compatibility: Fits all ADA-conforming 20"x18" wall-hung china lavatories.
      i. Paintability: Apply acrylic enamel or Latex.
      j. UL Listing: In accordance with ADA Article 4.19.4.
      k. Flammability: UL-94 V-0, 5VA ASTM D-635-91 4 (ATB) 2.1 (AEB).
   4. Bacterial/Fungal Resistance: ASTM G21 and G22/Result 0.

2.5 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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.

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

3.2 ADJUSTING AND CLEANING

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

B. Remove temporary labels and protective coatings.

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

END OF SECTION 102813

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SECTION 104300 – EMERGENCY AID SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Evacuation Chairs and Cabinets.

1.2 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection cabinets.
   1. 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.

1.3 QUALITY ASSURANCE

A. Reference Standards:
   1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
   2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
   3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
   4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
   5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
   6. 2016 California Energy Code, Part 6, Title 24 CBSC.
   7. 2016 California Historical Code, Part 8, Title 24 CBSC.
   8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
   9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
   10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
   11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
   12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
   13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
   14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
   15. NFPA 20 - Stationary Pumps, 2016 Edition.
   16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
   17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
   18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
   19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.

20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 1 year.

B. Installer Warranty: 2 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Evacuation Chairs and Cabinets.
   1. Stryker.
   2. Or equal.

2.2 EVACUATION CHAIRS AND CABINETS.

A. Product: Model #6254 by Stryker or equal.
   1. Description: Lightweight, rugged aluminum construction. Two-piece molded ABS seat.
   2. Chair Dimensions:
      a. Height: 45 in.
      b. Width: 20.5 in.
      c. Depth: 28 in.
      d. Folded Depth: 11 in.
      e. Weight: 34 lb.
      f. Maximum Load: 500 lb.
   3. Storage Cabinet: Model #6254-002-000.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install components in accordance with manufacturer's written instructions.

END OF SECTION 104300

SECTION 104400 - FIRE-PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Portable fire extinguishers.
   2. Fire-protection cabinets for the following:
      a. Portable fire extinguishers.

B. Related Sections include the following:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 7 Section "Through-Penetration Firestop Systems" for firestopping sealants at fire-rated cabinets.
   3. Division 10 Section "Signage" for directional signage to out-of-sight fire extinguishers and cabinets.

1.2 SYSTEM DESCRIPTION

A. Fire Extinguisher Cabinets:
   1. Fire Extinguisher Cabinets must comply with CBC Sections 11B-307, 11B-308, 11B-309 and 11B-403.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection cabinets.
   1. Fire Extinguishers: Include rating and classification.
   2. 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. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content, and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".
   2. Product Data for Credit MR 5: For products having regional content, documentation indicating location and distance from project of material manufacturer and extraction, with cost and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".

C. Samples for Initial Selection: For fire-protection cabinets with factory-applied color finishes.

D. Samples for Verification: For each type of exposed factory-applied color finish required for fire-protection cabinets, prepared on Samples of size indicated below.
   1. Size: 6 by 6 inches square.

E. Maintenance Data: For fire extinguishers and fire-protection cabinets to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Reference Standards:
   1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
   2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
   3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
   4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
   5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
   6. 2016 California Energy Code, Part 6, Title 24 CBSC.
   7. 2016 California Historical Code, Part 8, Title 24 CBSC.
   8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
   9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
   10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
   11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
   12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
   13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
   14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
   15. NFPA 20 - Stationary Pumps, 2016 Edition.
   16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
   17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
   18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
   19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
   20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
   21. Americans with Disabilities Act (ADA), Title II.

B. Source Limitations: Obtain fire extinguishers and fire-protection cabinets through one source from a single manufacturer.

C. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, 2007 Edition, "Portable Fire Extinguishers."

D. 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.

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

1.5 COORDINATION

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

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable 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: 6 years.

B. Installer Warranty: 2 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fire Extinguishers and Cabinets: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
   1. JL Industries, Inc. (Basis of Design)
   2. Larsen's Manufacturing Company.
   3. Potter Roemer; Div. of Smith Industries, Inc.
   4. Ansul.
   5. Or equal.

2.2 MATERIALS

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

B. Tempered Break Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 1.5 mm thick minimum.

2.3 PORTABLE FIRE EXTINGUISHERS

A. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
   1. Valves: Manufacturer's standard.
   2. Handles and Levers: Manufacturer's standard.

3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and Title 19 CCR.
4. Certification Tag: Provide fire extinguisher with valid certification test tag where fire extinguishers are fully charged and ready to be used.

B. Dry Chemical Type: Cast steel tank, with pressure gage.
1. Class 2A-10B:C.
2. Nominal Capacity: Provide largest capacity fire extinguisher that will fit in the cabinet, but 5 lbs. minimum.
3. Finish: Baked enamel, red color.
4. Use: General purpose.

C. Wet Chemical Type: Cast steel tank, pressurized, including hose and nozzle, with bracket.
1. Class 2A-K.
2. Size 2.5 gal.
3. Finish: Factory baked enamel, red color.
4. Use: At kitchens.

2.4 FIRE-PROTECTION CABINET

A. Product: ALTA by Potter Roemer.
1. Cabinet Size: Suitable for fire extinguisher.
2. Mounting: Recessed. Provide semi-recessed where recessed can't be provided.
3. Door and Frame Material:
   a. Steel: Cold rolled steel with electostatically applied thermally fused coating. Color as selected by Architect from manufacturer's full range.
4. Door Style: Full break glass.
5. Glazing: 1/4 inch tempered obscured glass.
6. Lettering: Vertical; red, white, or black as selected by Architect.

2.5 MOUNTING BRACKETS (WHERE REQUIRED)

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
1. Color: Red.

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.
   a. Orientation: Vertical.

2.6 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. Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- thick, cold-rolled steel sheet lined with minimum 5/8-inch- thick, fire-barrier material.
   a. Provide factory-drilled mounting holes.

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. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.7 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. Finish fire-protection cabinets after assembly.

D. 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.

2.8 STEEL FINISHES

A. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond using manufacturer's standard methods.

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where cabinets will be installed.

B. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged units.

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

3.2 PREPARATION

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

3.3 INSTALLATION

A. General: Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights indicated on Drawings.

B. Fire-Protection Cabinets: Fasten fire-protection 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.

END OF SECTION 104400

SECTION 105113 - METAL LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. All-welded metal lockers.
   2. Locker benches.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Lockers: CBC Section 11B-225.2.1.
      a. At least 5%, but no fewer than one of each type of lockers shall comply with CBC Section 11B-811.
   2. Locker Benches: 24 by 48 inch minimum size for accessible use.

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 each type of metal locker and bench.

B. LEED Submittal:
   1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
   2. Product Data for Credit MR 5.1 and Credit MR 5.2**:** Product data for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

C. Shop Drawings: For metal lockers. Include plans, elevations, sections, details, and attachments to other work.
   1. Provide calculations and details for anchorage of lockers per ASCE 13.5.
   2. Show locker trim and accessories.
   3. Include locker identification system and numbering sequence.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For metal lockers and locker benches, in manufacturer's standard sizes.

F. Qualification Data: For qualified Installer.

G. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

H. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

A. Reference Standards:
1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
6. 2016 California Energy Code, Part 6, Title 24 CBSC.
7. 2016 California Historical Code, Part 8, Title 24 CBSC.
8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
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13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
15. NFPA 20 - Stationary Pumps, 2016 Edition.
16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

C. Source Limitations: Obtain metal lockers, locker benches, and accessories from single source from single manufacturer.

D. Regulatory Requirements: Where metal lockers and benches are indicated to 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.

E. Preinstallation Conference: Conduct conference at Project site.

1.5 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 to Owner by registered mail or overnight package service.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.7 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.

1.8 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.

B. Installer's Warranty: 2 years.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. 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 five units:
      a. Locks.
      b. Identification plates.
      c. Hooks.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. All-Welded Lockers: Subject to compliance with requirements, provide products by one of the following manufacturers
   1. DeBourgh Mfg. Co. (District standards).
   2. Penco Products, Inc., Subsidiary of Vesper Corporation.
   3. Art Metal Products, Div. of Fort Knox Storage Co.
   4. Lyons.
   5. Or equal.

2.2 MATERIALS

A. Metallic-Coated Steel Sheet: ASTM A 653, Commercial Steel (CS), Type B; with A60 zinc-iron, alloy (galvannealed) coating designation.

B. Expanded Metal: ASTM F 1267, Type II (flattened), Class I, 3/4-inch steel mesh, with at least 70 percent open area.

C. Steel Tube: ASTM A 500, cold rolled.

D. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.

E. 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, and elsewhere as indicated, for corrosion resistance.
   2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.3 ALL-WELDED METAL LOCKERS

A. Product: Corregidoor Physical Education (PE) Lockers by DeBourgh or equal.
   1. Locker Configuration: As indicated on Drawings.
   2. Locker Construction:
      a. Lockers to be welded unibody construction with exposed welds sanded smooth.
      b. No bolts, screws or rivets used in assembly of locker units.
      c. Ship lockers set-up, ready to be anchored in place in accordance with manufacturer's instructions.
   3. Body of Lockers:
      a. Sides and Intermediate Partitions: Exterior sides constructed of 16 gauge domestic cold rolled sheet steel for maximum durability with 18 gauge intermediate partitions. Intermediate partitions to be diamond perforated for maximum ventilation.
      b. Backs: Solid sheet of 18 gauge cold rolled sheet steel welded to frames of sides and intermediate partitions.
      c. Shelves and Tier Dividers: 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.

4. Continuous Door Strike:
   a. Tier dividers, tops and bottoms constructed to provide four-sided, continuous door strike for a secure, sanitary and intrusion-free locker while door is in closed position.
5. Doors:
   a. Doors are 16 gauge CRS formed outer panel with double bends on both sides and a single bend on top and bottom with 18 gauge steel formed stiffener panel.
   b. 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 locker 12 inches high or less).
6. Door Ventilation:
   a. Diamond Perforated with 1/2 inch by 1-3/8 inch diamond perforations providing 37% ventilation per square inch.
   b. Secur-N-Vent doors with three-dimensional vertical vents formed on fronts and backs of door providing 21% ventilation per square inch.
7. Latching:
   a. Sentry III Single-Point Latch
      1) Eleven gauge stationary latch welded securely to locker frame.
      2) Latch extends no more than 1-1/4 inch into locker opening, penetrating through cup.
      3) Flush-mounted, recessed stainless steel cup in a formed door with 18 gauge vertical back panel stiffener.
8. Hinges:
   a. 16 gauge continuous piano hinge on the right side of the opening.
   b. Hinges welded to door and riveted to locker frame.
9. Slope Tops:
   a. Provide 18 gauge all welded slope top with 25 degree pitch, attached at factory with concealed fasteners. Slope top to be in addition to standard 16 gauge flat top.
10. Closed Base:
    a. Provide 4 inch high, 14 gauge welded steel base enclosed on all four sides securely welded to locker bottom.
11. Reinforced Bottom:
    a. Provide 16 gauge spacer channel welded to locker bottom from front to back for a more secure installation Spacer channel to have full height 1/2 inch ID tube welded over anchor holes to eliminate deflection upon locker installation. Spacer channel meets all California installation seismic requirements. (When closed bases are not used).
12. Filler Panels: Manufacturer's standard fabricated from 18 gauge solid steel finished to match lockers.
13. Finish:
    a. Complete locker unit to be thoroughly cleaned, phosphatized and sealed.
    b. Finish to be baked powder coat with a minimum 2-3 mil thickness.
    c. Color of lockers shall be chosen from manufacturer's 25 standard colors.
14. Accessories:
    a. Hooks:
       1) Hooks to be heavy duty forged steel with ball ends and zinc plated.
       2) Provide two single ceiling hooks and one double ceiling hook in each locker opening 20 inches or taller.
    b. Numbering
       1) Furnish each locker with black anodized laser-etched aluminum number plate.
       2) Locate number plate near center of each door.

3) Owner to furnish numbering sequence.

2.4 LOCKER BENCHES

A. Provide bench units with overall assembly height of 17-1/2 inches.

B. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.
1. Locker Benches: 24 by 48 inch minimum size for accessible use.

C. Fixed Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors, and as follows:
1. Tubular Steel: 1-1/2-inch- diameter steel tubing threaded on both ends, with standard pipe flange at top and bell-shaped cast-iron base; with baked-enamel or powder-coat finish; anchored with exposed fasteners.
a. Color: As selected by Architect from manufacturer's full range.

2.5 ACCESSORIES

A. External mail / file holders:
1. Product: Unbreakable Wall File, Vertical, Clear Item #21674 by Officemate or equal.
a. Guaranteed for lifetime filing needs.
b. Made from unbreakable plastic.
c. Attached to metal locker surfaces using heavy duty Clips and Fasteners.
d. Made in USA.

2.6 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.
3. Provide International Symbol of Accessibility.

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.

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 and bottom of lockers 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.

D. Fixed Locker Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than 72 inches apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor bases to floor.

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 105113

SECTION 105613 - METAL STORAGE SHELVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Industrial Shelving.
   2. Pallet Rack Shelving.
   3. Storage Cabinets.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Metal storage shelving shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Seismic Component Importance Factor: 1.0.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal storage shelving.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content, and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".
   2. Product Data for Credit MR 5: For products having regional content, documentation indicating location and distance from project of material manufacturer and extraction, with cost and LEED Product Submittal Cover Sheet from Division 1 Section "Sustainable Design Requirements".

C. Product Schedule: For metal storage shelving. Use same designations indicated on Drawings.

D. Maintenance Data: For metal storage shelving to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Reference Standards:
   1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
   2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).

3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
6. 2016 California Energy Code, Part 6, Title 24 CBSC.
7. 2016 California Historical Code, Part 8, Title 24 CBSC.
8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
15. NFPA 20 - Stationary Pumps, 2016 Edition.
16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

C. Source Limitations: Obtain metal storage shelving from single source from single manufacturer.

D. Preinstallation Conference: Conduct conference at Project site.

1.5 PROJECT CONDITIONS

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

1.6 COORDINATION

A. Coordinate sizes and locations of blocking and backing required for installation of metal storage shelving attached to wall and ceiling assemblies.

B. Coordinate locations and installation of metal storage shelving that may interfere with ceiling systems including lighting, HVAC, speakers, sprinklers, access panels, electrical switches or outlets, and floor drains.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal storage shelving that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: 1 year.

B. Installer Warranty: 2 years.

1.8 EXTRA MATERIALS

A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Shelves: Full-size units equal to 5 percent of amount installed for each type indicated, but no fewer than five shelves.
   2. Shelf-to-Post Connectors: Full-size units equal to 5 percent of amount installed for each type indicated, but no fewer than 10 connectors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Industrial Clip Storage Shelving: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
   1. Western Pacific Storage Systems (Basis of Design).
   2. Or equal.

B. Pallet Rack System:
   1. Hannibal Pallet Rack. (Basis of Design).
   2. Or equal.

C. Storage Cabinets
   1. HON. (Basis of Design)
   2. Or equal.

2.2 MATERIALS

A. Hot-Rolled Steel Sheet: ASTM A 1011, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

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

C. Floor Anchor: Industrial Shelving and Pallet Racks will be anchored to the floor per the Structural Engineer's stamped anchoring calculations.

2.3 INDUSTRIAL CLIP SHELVING

A. Factory-formed, metal post. Angel Posts in Back and Delta Post in Front 85"H. X metal back brace and X metal side brace. 20 gauge clip supports. Seismic Metal Foot Plates for anchoring.
   1. Product: by Western Pacific Storage Systems.
   2. Shelves: Metal
   3. Completely freestanding.
   4. Shelves adjust at 1-1/2" increments.
   5. Standard stock color: Gray or Black

2.4 PALLET RACK SYSTEM

A. Product: Pallet Rack Plus by Hannibal or equal.
   1. Description: Upright Frames and Beams.
   2. Step down design:
      a. Beams have a step for the purpose of accepting accessories.
      b. Two step sizes are available: 7/8 " and 1-5/8" high.
   3. Beam Locking Key:
      a. Recessed safety key installed into each beam connector that is made from heavy gauge steel engages a slot in the side of the post.
      b. As soon as beams are installed, the locking key should be slid into place.
      c. Resist an upward force from material handling equipment up to 1000 pounds.
      d. It is an integral part of the beam assembly, can be engaged easily without tools, and is clearly visible for checking.
   4. Heavy Duty Beam End connector:
      a. Beam capacity is 5600 pounds.
      b. Pallet rack beam can be equipped with four-pronged connectors.
   5. Welded Upright Frame Bracing:
      a. Upright frame columns are securely MIG welded together with channel type braces for maximum rigidity.
   6. Upright column:
      a. Continuous post roll formed into an "M" design for added strength.
      b. Slanted slots on the column allow for beam placement on 3" vertical centers.
      c. The greater the unit load the tighter the beam-upright connection becomes.
      d. Beams are attached 3" down from the top of the heavy duty connector and cannot be installed flush with the top of the uprights.
   7. Foot Plate:
      a. End frames have footplates that are 5' x 8".

   8. Pallet Rack Frames:
      a. Upright Frames are available in five different load carrying ranges.
      b. A letter code stamped into the face of the post indicates the frame type.
      c. Depths of 48"
      d. Heights of frames are 10' feet high.
      e. Upright frames shall be securely anchored to the floor.
      f. Seismic conditions and local codes may require anchors other than the standard anchors.
   9. Pallet Rack Beams:

a. Penco has engineered its roll-formed one piece beam to achieve the highest possible strength-to-weight ratios in the most frequently desired load ratings through the use of efficient design and high strength steel.
b. Beams are offered in eight basic styles with different vertical profiles and steel gauges. Beam step heights of 7/8" and 1-5/8" are available for a wide variety of accessory use. Both the overlapping seam and the beam end connector are securely MIG welded for strength.
c. The face of the beam has an M-design recessed configuration for added strength, protecting the locking key, and to accept pressure sensitive labeling. Each beam is stamped with an identifying letter referring to the load bearing capacity. Beams are finished in 710 Sagebrush Yellow baked enamel for high visibility. Safety Yellow and any other standard Penco colors are available upon request.
d. For adding to height of existing frame.
e. Can be supplied welded in top of new frame if specified on order. (Top frame must be ordered without foot plate.) with hardware.
f. Can be used with standard or Plus uprights. Length of splice allows for two bolt locations on each side of the splice joint. Hardware for attachment is included. Top frames must be ordered without footplates.

2.5 STORAGE CABINETS

A. Product: hon Brigade - HSC2472 by HON or equal.
1. Description: Locking metal storage cabinet (min. 6 adjustable shelves), anchor to back wall per manufacturer's recommendations.
2. Hardware: Locks, keyed alike.
3. Color: Putty (Beige),

2.6 GENERAL FINISH REQUIREMENTS

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

B. 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.

2.7 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 or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine floors for suitable conditions where metal storage shelving will be installed.

C. Examine walls to which metal storage shelving will be attached for properly located blocking, grounds, or other solid backing for attachment of support fasteners.

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

3.2 PREPARATION

A. Vacuum finished floor and wet mop resilient flooring over which metal storage shelving is to be installed.

3.3 INSTALLATION

A. Install metal storage shelving level, plumb, square, rigid, true, and with shelves flat and free of dents or distortion. Make connections to form a rigid structure, free of buckling and warping.
   1. Install exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
   2. Install braces, straps, plates, brackets, and other reinforcements as needed to support shelf loading and as required for stability.
   3. Adjust post-base bolt leveler to achieve level and plumb installation.
   4. Anchor shelving units to floor with floor anchors through floor plate. Shim floor plate to achieve level and plumb installation.
   5. Install seismic restraints.
   6. Connect side-to-side shelving units together.
   7. Install shelves in each shelving unit at spacing indicated on Drawings or, if not indicated, at equal spacing.

3.4 ERECTION TOLERANCES

A. Erect four-post metal storage shelving to a maximum tolerance from vertical of 1/2 inch in up to 10 feet of height, not exceeding 1 inch for heights taller than 10 feet.

3.5 ADJUSTING

A. Adjust metal storage shelving so that connectors and other components engage accurately and securely.

B. Adjust and lubricate operable components to operate smoothly and easily, without binding or warping. Check and readjust operating hardware.

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

D. Replace metal storage shelving that has been damaged or has deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 105613

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SECTION 108600 – SECURITY MIRRORS AND DOMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Security dome mirrors.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

A. Reference Standards:
   1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
   2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
   3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
   4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
   5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
   6. 2016 California Energy Code, Part 6, Title 24 CBSC.
   7. 2016 California Historical Code, Part 8, Title 24 CBSC.
   8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
   9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
   10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
   11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
   12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
   13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
   14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
   15. NFPA 20 - Stationary Pumps, 2016 Edition.
   16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
   17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
   18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
   19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
   20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
   21. Americans with Disabilities Act (ADA), Title II.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of security mirrors and domes that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: 1 year.

B. Installer Warranty: 2 years.

PART 2 - PRODUCTS

2.1 SECURITY DOME MIRRORS

A. Product: 18 Inch 180 Degree Viewing 1/2 Dome Mirror by Safety Mirror USA or equal.
   1. 18 Inch 180 Degree Viewing 1/2 Dome Mirror.
   2. Excellent for T-Intersections.
   3. Pressure Formed.
   4. Mount Directly to Ceiling or Wall.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install security dome mirrors to comply with mirror manufacturer's written instructions.

END OF SECTION 108600

SECTION 111300 - LOADING DOCK EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Dock bumpers.
   2. Dock levelers.

B. Related Sections include the following:
   1. Division 26 Section "Interior Lighting" for dock lighting fixtures.
   2. Division 26 Sections for electrical wiring and connections for loading dock equipment.

1.2 SUBMITTALS

A. Product Data: Include construction details, material descriptions, rated capacities, operating characteristics, furnished specialties, accessories, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Maintenance Data: For loading dock equipment to include in maintenance manuals.

D. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

A. Reference Standards:
   1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
   2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
   3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
   4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
   5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
   6. 2016 California Energy Code, Part 6, Title 24 CBSC.
   7. 2016 California Historical Code, Part 8, Title 24 CBSC.
   8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
   9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.

10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
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17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   1. Maintenance Proximity: Not more than 2 hours' normal travel time from Installer's place of business to Project site.

C. Source Limitations: Obtain each type of loading dock equipment through one source from a single manufacturer.

D. Preinstallation Conference: Conduct conference at Project site.

1.4 COORDINATION

A. Coordinate installation of anchorages for loading dock equipment. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Recessed Loading Dock Equipment: Coordinate size and location of pits to ensure proper clearances and operation of equipment.

C. Electrical Requirements: Coordinate wiring requirements and current characteristics of loading dock equipment with building electrical system. See Division 16 Sections.

1.5 WARRANTY

A. Special Warranty for Dock Levelers: Manufacturer's standard form in which manufacturer agrees to repair or replace dock-leveler components that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including cracked or broken structural support members and load-bearing welds.
      b. Deck plate failures including cracked plate or permanent deformation in excess of 1/4 inch between deck supports.
      c. Hydraulic system failures including failure of hydraulic seals and cylinders.
      d. Faulty operation of operators, control system, or hardware.

2. Warranty Period for Structural Assembly: 10 years.
3. Warranty shall be for unlimited usage of the leveler for the specified rated capacity over the term of the warranty.

B. Installer's Warranty: 2 years.

1.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of loading dock equipment Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
1. Perform maintenance, including emergency callback service, during normal working hours.
2. Include 24-hour-per-day, 7-day-per-week emergency callback service.

B. Continuing Maintenance Service: Provide a continuing maintenance proposal from Installer to Owner, in the form of a standard yearly maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Dock Bumpers:
1. Rite Hite. (Basis of Design)
2. Kelley Company, Inc.
3. Pentalift Equipment Corp.
4. Poweramp System Inc.
5. Or equal.

B. Dock Levelers:
1. Rite Hite. (Basis of Design)
2. Kelly Dock Levelers.
3. Pentalift Equipment Corp.
4. Poweramp System. Inc.
5. Or equal.

2.2 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.

C. Steel Tubing: ASTM A 500, cold formed.

D. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.3 DOCK BUMPERS

A. Laminated-Tread Bumpers: 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.

B. 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.

2.4 DOCK LEVELERS

A. Product: RHH 4000 Series Hydraulic Dock Levelers by Rite-Hite, or equal.
1. Type: Recessed adjustable dock levelers.
2. Size: As indicated on Drawings.
3. Operational range of 12" above and below dock level.
4. Equip each unit with two (2), 12" high x 4" deep laminated dock bumpers.
5. ANSI MH30.1-2000 test load specifications with proper documentation from a 3rd party.
6. Platform shall have a minimum of (8) interior deck beams plus external working range toe-guards with no more than 8" spacing between the beams.
7. When leveler is in stored position, the leveler lip will provide an integral and automatically-positioned, impact-rated, solid barrier 5" above building floor to help prevent accidental falls from vacant dock positions.
8. Unobstructed end loading shall be possible from below dock level.
9. Overlapping platform barriers or pinch points are not acceptable.
10. Levelers shall automatically return to safe, stored position if the trailer departs.
11. Automatic night locks to be integral part of manufacturer's standard dock levelers.
12. Full operating range telescoping toe guards to close off sides when leveler is in the highest upward position. Working range of 12".
13. Positive acting Safe-T-Strut™ maintenance support system will support lip and deck.
14. This system must withstand a 10,000 lb. moving load and provide OSHA approved lockout/tag-out capabilities.
15. Levelers shall have ramp flex of 4" to compensate for unlevel trailer beds. Rear hinges shall be fixed and shall not rise above floor level.
16. Dock leveler control box: All individual components, as well as the complete box unit, shall be UL-approved.
17. Control box shall include infinite lip control to extend the lip at any time during the operation of the leveler and shall also provide a constant pressure emergency stop.
18. Leveler shall include brush style weatherseal.
19. Hydraulic fluid shall be biodegradable and have a pour point of -80 degrees below zero.

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. Examine roughing-in for electrical systems for loading dock equipment to verify actual locations of connections before equipment installation.

C. Examine walls and floors of pits for suitable conditions where recessed loading dock equipment is to be installed. Pits shall be plumb and square and properly sloped for drainage from back to front of loading dock.

D. 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. Clean recessed pits of debris.

3.3 INSTALLATION

A. 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. 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.
   2. Screw Attachment: Attach dock bumpers to wood construction with lag bolts as indicated.

B. Dock Levelers: Attach dock levelers securely to loading dock platform, flush with adjacent loading dock surfaces and square to recessed pit.

3.4 ADJUSTING AND CLEANING

A. Adjust loading dock equipment for proper, safe, efficient operation.

B. Set and adjust upper travel limit switch and test for vertical travel within operating range indicated.

C. Restore marred, abraded surfaces to their original condition.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain loading dock equipment.

END OF SECTION 111300

SECTION 11 40 00 - FOOD SERVICE EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. The work referred to in this section consists of furnishing all labor and material required to provide and deliver all food service equipment hereinafter specified into the building, uncrate, assemble, hang, set in place, level, and completely install, exclusive of final utility connections. Final utility connections to all equipment, shall be part of the work under additional appropriate sections of the work and not part of the food service work.

1. The equipment and its component parts shall be new and unused. All items of standard manufactured equipment shall be current models at the time of delivery. Parts subject to wear, breakage, or distortion shall be accessible for adjustment, replacement and repair.

2. Each refrigeration items specification is written to provide minimum specifications and scope of work. Refrigeration equipment shall be designed and installed to maintain the following general temperature unless otherwise specified.

a.	N/A	
b.	N/A	
c.	Reach-In Refrigerators	1.7°C / 35°F
d.	Reach-In Freezers	-23.2°C / -10°F
e.	Undercounter Refrigerators	1.7°C / 35°F
f.	Undercounter Freezers	-23.2°C / -10°F
g.	Cold Pan	5°C / 41°F

3. The materials or products specified herein by trade names, manufacturer's name or catalog number shall be provided as specified. Substitutions will not be permitted unless approved by owner's representative in writing no later than 10 days prior to bidding. This stipulation applies to all equipment and materials. All substitutions or alternates will be expected to perform in all respects as well as the original specification. Should no request for substitution be received and approved as listed above, the project is to be provided as specified.

4. The food service equipment contractor shall be responsible for all costs associated with the acceptable alternate or approved alternate items, if the item requires additional space or specific utilities that differ from specifications or drawings. The FSEC is responsible for all coordination, documentation and costs associated with any alternate item that was not submitted for approval and accepted by the consultant prior to bid. The FSEC shall be responsible for any costs associated with building changes, utility changes and drawings changes.

B. Coordinate Owner and Vendor-supplied equipment noted on the drawings or in the specifications as NIFSEC, "not in food service equipment contract". Show on roughing in Plans and sizes,

utilities, and other requirements as furnished in the specifications, by owner or appropriate supplier in submittals as if the equipment is contractor furnished.

C. Bidders shall carefully examine the specifications and the project site including location and condition of existing equipment to determine cost for each "Existing-Reset" and "Existing-Modify" item to cover removal, modification (including materials), cleaning, inspection for damage, repair and resetting.

D. Field measurements shall be made prior to fabrication or installation of any equipment item.

E. The cutting of holes in equipment for pipe, drains, electrical outlets, etc., required for this installation, shall be part of this work. Work shall conform to the highest standards of workmanship and shall include welded sleeves, collars, ferrules and escutcheons.

F. Repair of all damage to the premises as a result of the equipment installation as well as the removal of all debris left by the work of this section.

G. Food service equipment and fixtures shall be cleaned and ready for operation at the time the facility is turned over to the Owner for final inspection by the Owner's Representative.

H. Food Service Equipment Contractor shall be responsible for coordinating with the Architect and Contractor in submitting all applicable documents.

I. All bidders shall submit with their costing a list of the subcontractors that are included in their bids and a complete "schedule of values" for all equipment and labor.

1.2 RELATED SECTIONS

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

B. Related Work In Other Sections by appropriate trades include the following:

1. Division 5 Section "Metal Fabrications" for equipment supports.

2. Division 6 Section "Interior Architectural Woodwork" for wood casework and plastic laminate substrates.

3. Refer to Division 23 Sections for supply and exhaust fans; exhaust ductwork; service roughing-ins; drain traps; atmospheric vents; valves, pipes, and fittings; fire extinguishing systems; and other materials required to complete food service equipment installation.

4. Refer to Division 26 & 28 Sections for connections to fire alarm systems, wiring, disconnects, and other electrical materials required to complete food service equipment installation.

C. All electric services including wiring to, and final connections to, the fixtures except, as specified differently in the specifications, drawings, or herein.

D. All water, waste and gas services to the fixtures including shut-off valves, trim, traps, etc., and final connections to the fixtures, except as specified differently in the specifications, drawings, or herein.

E. All hood or ventilator duct work above the connection position on such exhaust hoods or exhaust ventilators, except as specified differently in the specifications, drawings, or herein. Final welded connections at the junction point of exhaust hoods or exhausts ventilators, shall be part of the food service work.

F. Floors, quarry tile, concrete bases, walls, ceilings, finishes and related building work, except as specified differently in the specifications, drawings or herein.

1.3 DEFINITIONS

A. Terminology Standard: Refer to NSF 2, "Food Equipment", NSF 4, Heated Cabinets, NSF 7, Refrigerated Equipment, or other applicable NSF standards for definitions of food service equipment and installation terms not otherwise defined in this Section or in other referenced standards.

B. FSEC: Food Service Equipment Contractor

C. Owner-Furnished Equipment: Where indicated, Owner will furnish equipment items.

D. Vendor-Furnished Equipment: Where indicated the Owner's or operator's vendor will furnish equipment items.

E. NIFSEC: Not Included in Food Service Equipment Contract.

1.4 SUBMITTALS

A. Regardless of drawing formats provided it will remain the responsibility of equipment supplier to develop submittals in accordance with the Specific Conditions and assume all required responsibilities there to. The consultant is not to be liable for errors or omissions by the FSEC's use of electronic data provided by the Consultant or the development of date used in the submittal approval process. Checking product data, rough-in drawings, wall backing drawings, shop drawings, and refrigeration drawings by Designer is for design concept only, and does not relieve the Food Service Equipment Contractor of responsibility for compliance with Contract Documents, verification of utilities with equipment requirements for conformity and location, verification of all dimensions of equipment and building conditions or reasonable adjustments due to deviations.

B. The Food Service Equipment Contractor shall review and provide an affidavit with each submittal that such review has been completed by an authorized agent of the contractor.

C. Product Data: For each type of food service equipment indicated. Include manufacturer's model number and accessories and requirements for access and maintenance clearances, water and drainage, power or fuel, and service-connections including roughing-in dimensions.

D. Shop Drawings: For food service equipment not manufactured as standard production and catalog items by manufacturers. Include plans, elevations, sections, material schedule, roughing-in dimensions, fabrication details, service requirements, and attachments to other work.

1. Wiring Diagrams: Details of wiring for power, signal, and control systems and differentiating between manufacturer-installed and field-installed wiring.

2. Piping Diagrams: Details of piping systems and differentiating between manufacturer-installed and field-installed piping.

E. Coordination Drawings: For locations of food service equipment and service utilities. Key equipment with item numbers and descriptions indicated in Contract Documents. Include plans and elevations of equipment, access- and maintenance-clearance requirements, details of concrete, masonry or metal bases and floor depressions, and service-utility characteristics. Ventilation requirements for refrigerated equipment shall be identified in these drawings.

F. Contract Document Drawings:

1. Drawings furnished, constitute a part of these specifications and show locations of equipment and general arrangement of mechanical and electrical services. Necessary deviation from the illustrated arrangements to meet structural conditions, shall be considered a part of the work of this section. Such deviations shall be made without expense to the owner. Equipment drawings are definitive only and should not be used as construction documents or shop details.

2. The drawings are for the assistance and guidance of the Food Service Equipment Contractor. Exact locations shall be governed by the building configuration. The Food Service Equipment Contractor shall accept his contract with this understanding.

3. Should there be a conflict between the drawings and the specifications, the specifications shall govern.

G. Utility Roughing-in Drawings:

1. The Food Service Equipment Contractor shall prepare and submit one electronic file or two bond or a valid prints, of all roughing-in drawings, showing information necessary for the roughing-in of refrigerant lines, syrup/beer lines, plumbing, steam, mechanical and electrical utility requirements. Drawings shall also include construction requirements necessary for all equipment including floor depressions, raised bases, wall blocking, wall recesses and any critical dimensions for specific equipment requirements. Acceptance will be made upon the electronic file or one print which will be returned to the Food Service Equipment Contractor for reproduction purposes. Drawings not properly submitted in this format, will not be reviewed. Drawings without an "Accepted" or an "Accepted as Noted" stamp, will not be reviewed. Drawings without an" Accepted as noted" stamp, will not be considered an authorized shop drawing and will not be allowed on the job site.

a. Furnish four (4) sets "Accepted" and/or "Accepted as Noted" shop drawings, for distribution to the field, as directed.

H. Shop Fabrication Drawings: The fabricator of the equipment shall prepare and submit through the Food Service Equipment Contractor one electronic file or two bond or original prints, of all shop drawings, showing all information necessary for fabrication and installation of the work of this section. Acceptance will be made upon the electronic file or one print which will be returned to the Food Service Equipment Contractor for reproduction purposes. Drawings not properly submitted in this format, will not be reviewed. Drawings without an "Accepted" or an "Accepted as Noted" stamp, will not be considered an authorized shop drawing and will not be allowed on the job site.

I. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for exposed products with color finishes.

J. Samples for Verification: Of each type of exposed finish required, minimum 4-inch- (100-mm-) square or 6-inch- (150-mm-) long sections of linear shapes and of same thickness and material indicated for work. Where finishes involve normal color and texture variations, include Sample sets showing the full range of variations expected.

K. Product Certificates: Signed by manufacturers of refrigeration systems, refrigerated equipment or their authorized agents certifying that systems furnished comply with NSF 7 requirements and will maintain operating temperatures indicated in the areas or equipment that they will serve.

L. Maintenance Data: Operation, maintenance, and parts data for food service equipment to include in the maintenance manuals specified in Division 1. Include a product schedule as follows:

1. Product Schedule: For each food service equipment item, include item number and description indicated in Contract Documents, manufacturer's name and model number, and authorized service agencies' addresses and telephone numbers.

1.5 QUALITY ASSURANCE AND LAWS AND ORDINANCES

A. Installer Qualifications: Engage an experienced installer to perform work of this Section who has specialized in installing food service equipment, who has completed installations similar in design and extent to that indicated for this Project, and who has a record of successful in service performance.

B. Manufacturer Qualifications: Engage a firm experienced in manufacturing food service equipment similar to that indicated for this Project and with a record of successful in-service performance.

C. Source Limitations: Obtain each type of food service equipment through one source from a single manufacturer.

D. Product Options: Drawings indicate food service equipment based on the specific products indicated. Other manufacturers' equipment with equal size and performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

E. Regulatory Requirements: Comply with the following National Fire Protection Association (NFPA) codes:

1. NFPA 17, "Dry Chemical Extinguishing Systems."

2. NFPA 17A, "Wet Chemical Extinguishing Systems."

3. NFPA 54, "National Fuel Gas Code."

4. NFPA 70, "National Electrical Code."

5. NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations."

6. The FSEC shall certify that all work and materials comply with Federal, State and Local laws, ordinances, and regulations and is confirmed by the local inspector having jurisdiction.

a. US PUBLIC HEALTH SERVICE

b. LOCAL HEALTH DEPARTMENT

c. NATIONAL BOARD OF FIRE UNDERWRITERS

d. OSHA

e. UL

f. HACCP

g. NFPA 96 – Current

h. ADA

i. OSHPD

j. DSA

F. Listing and Labeling: Provide electrically operated equipment or components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

G. AGA Certification: Provide gas-burning appliances certified by the American Gas Association (AGA).

H. ASME Compliance: Fabricate and label steam-generating and closed steam-heating equipment to comply with ASME Boiler and Pressure Vessel Code.

I. ASHRAE Compliance: Provide mechanical refrigeration systems complying with the American Society of Heating, Refrigerating and Air-Conditioning Engineers' ASHRAE 15, "Safety Code for Mechanical Refrigeration."

J. Food Service Equipment: Where provided, check-out aisles, sales counters, service counters, food service lines, queues, and waiting lines shall comply with CBC Sections11B-227 and 11B-904. The top of tray slides shall be 28" minimum and 34" maximum above finish floor. Space and elements within food service employee work areas shall meet the requirements of CBC Section 11B-203.9. Food service equipment required to be accessible shall conform to all reach requirements in CBC Figures 2013, 11B-403.5.1, 11B-227.4, 11B-904.5, 11B-904.5.1, and 11B-904.5.2.

K. NSF Standards: Comply with applicable NSF International (NSF) standards and criteria and provide NSF Certification Mark on each equipment item, unless otherwise indicated.

L. ANSI Standards: Comply with applicable ANSI standards for electric-powered and gas-burning appliances; for piping to compressed-gas cylinders; and for plumbing fittings, including vacuum breakers and air gaps, to prevent siphonage in water piping.

M. SMACNA Standard: Where applicable, fabricate food service equipment to comply with the Sheet Metal and Air Conditioning Contractors National Association's (SMACNA) "Food Service Equipment Fabrication Guidelines," unless otherwise indicated.

N. Seismic Restraints: Provide seismic restraints for food service equipment according to the Sheet Metal and Air Conditioning Contractors National Association's (SMACNA) "Food Service Equipment Fabrication Guidelines," appendix 1, "Guidelines for Seismic Restraints of Kitchen Equipment," unless otherwise indicated.

O. Pre-installation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings."

P. Pre-installation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings." Review methods and procedures related to food service equipment including, but not limited to, the following:

1. Review access requirements for equipment delivery.

2. Review equipment storage and security requirements.

3. Inspect and discuss condition of substrate and other preparatory work performed by other trades.

4. Review structural loading limitations.

5. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

Q. Walk-in cooler and/or freezer shall comply with CBC Figures 2013, 11B-404.2.4, 11B-404.2.4.4. 11B-404.2.7 and 11B-309.4.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver food service equipment as factory-assembled units with protective crating and covering.

B. Store food service equipment in original protective crating and covering and in a dry location.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions of food service equipment installation areas by field measurements before equipment fabrication and indicate measurements on Shop Drawings and Coordination Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish required dimensions and proceed with fabricating equipment without field measurements. Coordinate construction to ensure actual dimensions correspond to established dimensions.

2. Food service aisles shall be a minimum 36" wide and tray slides shall be mounted at 34" maximum above the floor. CBC Section 1104B.5, item 5.

3. Pass-thru windows for food service shall conform to the reach and access requirements of CBC sections 1118B: 1122B.5; 1104B.3.12 and 1104B.4.2 for accessible transaction areas. Accessible pass-thru shelves shall not exceed 34-inch height above interior finished floor surface or exterior pavement.

1.8 COORDINATION

A. Coordinate equipment layout and installation with other work, including light fixtures, HVAC equipment, and fire-suppression system components.

B. Coordinate location and requirements of service-utility connections.

C. Coordinate size, location, and requirements of concrete bases, positive slopes to drains, floor depressions, and insulated floors. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

D. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.9 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents. Warranty period: 2 year from date of completion.

B. Refrigeration Compressor Warranty: 5 years from date of completion. Submit a written warranty signed by manufacturer agreeing to repair or replace compressors that fail in materials or workmanship within the specified warranty period.

PART 2 - PRODUCTS

2.1 MATERIALS - METAL

A. Submit a certified copy of the mill analysis of materials if requested by the Architect.

B. Finish for exposed surfaces to be #4 polished, unless otherwise specified.

C. Protective covering shall be provided on all polished surfaces of stainless steel sheet work, and retained and maintained until time of final testing, cleaning, start-up and substantial completion.

D. Stainless-Steel Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304, stretcher leveled, and in finish specified in "Stainless-Steel Finishes" Article.

E. Stainless-Steel Tube: ASTM A 554, Grade MT-304, and in finish specified in "Stainless-Steel Finishes" Article.

F. Zinc-Coated Steel Sheet: ASTM A 653, G115 (ASTM A 653M, Z350) coating designation; commercial quality; cold rolled; stretcher leveled; and chemically treated.

G. Zinc-Coated Steel Shapes: ASTM A 36 (ASTM A 36M), zinc-coated according to ASTM A 123 requirements.

H. Sealant: ASTM C 920; Type S, Grade NS, Class 25, Use NT. Provide elastomeric sealant NSF certified for end-use application indicated. Provide sealant that, when cured and washed, meets requirements of Food and Drug Administration's 21 CFR, Section 177.2600 for use in areas that come in contact with food.

1. Color: As selected by Architect from manufacturer's full range of colors.

2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.

I. Sound Dampening: NSF-certified, nonabsorbent, hard-drying, sound-deadening coating. Provide coating compounded for permanent adhesion to metal in 1/8-inch (3-mm) thickness that does not chip, flake, or blister.

J. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds.

K. Casters: NSF-certified, heavy duty, stainless-steel, swivel stem casters with 5-inch- (125-mm-) diameter wheels, polyurethane tires with 1-inch (25-mm) tread width, and 200-lb (90-kg) load capacity per caster. Provide brakes on 2 casters per unit.

2.2 MATERIALS – CASEWORK/MILLWORK

A. Cabinet Hardware: Provide NSF-certified, stainless-steel hardware for equipment items as indicated. Pulls, Handles and Catches to be included.

B. All wood to be thoroughly seasoned and kiln dried prior to being used for fabrication of custom casework. All wood to be free from knots, pitchy seams, or other imperfections. All exposed wood to be grade A pine.

C. All plywood to be thoroughly seasoned and kiln dried prior to being used. All plywood to be free from knots, pitchy seams, and other imperfections. All plywood to be glued with water resistant resin. Particle board may not be substituted for plywood panels. "W.I. - Custom Grade" marine grade plywood is required on all fixtures to be installed in high humidity environments.

D. All wood to have less than 12% moisture content and be a species listed by the national hardwood association.

E. Plastic laminates shall be 1/16th thick, general purpose grade GP-50 as manufactured by Wilson Art or equal. Patterns, textures, and colors as specified under individual items. Semi ex-posed and cabinet liners shall be CL-20. Countertops, backsplashes and edges shall be grade GP-50 on exposed and grade BK-20 on underside of tops. Exposed vertical surfaces and cabinet liners shall be grade CL-20. Sides and edges of shelving shall be grade 50. Adhesive shall be waterproof and low VOC.

F. Hardware that is furnished and installed shall be of solid material unless specified otherwise. The hardware shall be provided with the necessary mechanisms for locking. All locks shall be furnished with two (2) keys.

G. Solid Surface Material (SSM) shall be Caesarstone, Silestone or approved equal and installed over 3/4" plywood per manufacturer's instructions. Provide air space, trim and /or insulation around any heat or cold producing equipment to guard against discoloration and cracking.

2.3 FABRICATION, GENERAL, METAL,

A. Fabricate food service equipment according to NSF (standards 2, 4 & 7) requirements. Factory assemble equipment to the greatest extent possible.

B. STAINLESS-STEEL EQUIPMENT: for all parts of custom tables, tops, benches, sinks, cabinets, etc., as drawn or as specified, shall be AICI type 304 (18-8 Austenitic). All gauges called for shall be U.S. Standard Gauges, “S/S” or “S.S.” as shown in the drawings or specifications, shall indicate stainless steel.

1. Edges and Backsplashes: Provide equipment edges and backsplashes indicated complying with referenced SMACNA standard, unless otherwise indicated.

2. Apply sound dampening to underside of metal work surfaces, including sinks and similar units. Provide coating with smooth surface and hold coating 1 inch (25 mm) back from open edges for cleaning.

3. Tables: Fabricate with reinforced tops, legs, and reinforced undershelves or cross bracing to comply with referenced SMACNA standard, unless otherwise indicated, and as follows:

    a. Tops: Minimum #14 gauge / 0.0781-inch- (1.984-mm-) thick stainless steel, unless otherwise indicated.

    b. Legs: 1-5/8 inch (41.3 mm) OD, minimum #16 gauge / 0.0625-inch- (1.588-mm-) thick stain-less steel with stainless-steel gusset and adjustable insert bullet-type feet with minimum adjustment of 1 inch (25 mm) up or down without exposing threads, unless otherwise indicated.

    c. Undershelves: Minimum #16 gauge / 0.625-inch- (1.588-mm-) thick stainless steel, unless otherwise indicated.

    d. Top and Undershelf Reinforcement: Provide minimum #14 gauge / 0.0781-inch- (1.984-mm-) thick, stainless-steel reinforcing, unless otherwise indicated.

    e. Cross Bracing: 1-1/4 inch (31.75 mm) OD, minimum #16 gauge / 0.0625-inch- (1.588-mm-) thick stainless steel, unless otherwise indicated.

4. Sinks: Fabricate of minimum #14 gauge / 0.0781-inch- (1.984-mm-) thick stainless steel with fully welded, 1-piece construction. Construct 2 sides and bottom of sink compartment from 1 stainless-steel sheet with ends welded integral and without overlapping joints or open spaces between compartments. Provide double-wall partitions between compartments with 1/2-inch- (13-mm-) radius rounded tops that are welded integral with sink body. Cove horizontal, vertical, and interior corners with 3/4-inch (19-mm) radius. Pitch and crease sinks to waste for drainage without pooling. Seat wastes in die-stamped depressions without solder, rivets, or welding.

    a. Wastes: 2-inch (50-mm), stainless steel ball valve, rotary-handle waste assembly with stainless-steel strainer plate, rough chrome plated body.

    b. Drainboards: Minimum #14 gauge / 0.0781-inch- (1.984-mm-) thick stainless steel, pitched to sink at 1/8 inch/12 inches (3 mm/300 mm) of length. Reinforce drainboards with minimum #14 gauge / 0.0781-inch- (1.984-mm-) thick stainless steel, unless otherwise indicated.

    c. Legs: 1-5/8 inch (41.3 mm) OD, minimum #16 gauge / 0.0625-inch- (1.588-mm-) thick stain-less steel with stainless-steel gusset welded to #12 gauge / 0.1094-inch- (2.779-mm-) thick, stainless-steel support plate. Provide adjustable insert bullet-type feet with minimum adjustment of 1 inch (25 mm) up or down without exposing threads, unless otherwise indicated.

    d. Drainboard Braces: 1 inch (25 mm) OD, minimum #16 gauge / 0.0625-inch- (1.588- mm-) thick stainless steel, unless otherwise indicated.

e. Cross Bracing: 1-1/4 inch (31.75 mm) OD, minimum #16 gauge / 0.0625-inch- (1.588-mm-) thick stainless steel, unless otherwise indicated.

5. Wall Shelves and Overshelves: Fabricate to comply with referenced SMACNA standard, unless otherwise indicated, and with minimum #16 gauge / 0.0625-inch- (1.588-mm-) thick, stainless-steel shelf tops.

6. Drawers: Provide lift-out type, 1-piece, die-stamped drawer pan fabricated from #18 gauge / 0.050-inch- (1.27-mm-) thick stainless steel with inside corners radiused. Support drawer pan with #16 gauge / 0.0625-inch- (1.588-mm-) thick, stainless-steel channel frame welded to drawer front. Provide 1-inch- (25-mm) thick, double-wall front fabricated from #16 gauge / 0.0625-inch- (1.588-mm-) thick stainless steel and with integral recessed pull. Fill void in drawer front with semi rigid fiberglass sound dampening. Mount drawers on NSF-certified, full-extension, stainless-steel drawer slides that have minimum 100-lb (45-kg) load capacity per pair, ball-bearing rollers, and positive stop. Mount drawer slides for self-closing on drawer housing as indicated.

7. Refrigerated Bases: Unit to be all welded construction and fabricated in accordance with NSF Standard 7.

   a. Top: 18 gauge galvanized sub-top or 14 gauge stainless steel top.

   b. Exterior: Front and Sides to be 18 gauge number 4 finish type 304 stainless steel; bottom and back to be 18 gauge galvanized (unless otherwise noted).

   c. Interior liner: 20 gauge number 4 finish type 304 stainless steel with 3/8" radius corners.

   d. Insulation: Minimum 2" thick polyurethane foam in place insulation (CFC free).

   e. Doors: 18 gauge front and 20 gauge door pan number 4 finish type 304 stainless steel with 2" polyurethane foam in place insulation, long-life press in place gasket.

   f. Drawers: 300 lb. capacity with 14 gauge stainless steel track system, tandem 2" all stainless steel skate wheels, each drawer accommodates two 6" deep, 12" x 20" pans side by side.

   g. Shelving: Each door section shall have stainless steel wire racks.

8. Refrigerated Pan Rails: Unit to be all welded construction and fabricated in accordance with NSF Standard 7.

   a. Top: 16 gauge number 4 finish type 304 stainless steel top and inner liner.

   b. Outer liner: To be 18 gauge type 304 stainless steel; bottom and back to be 18 gauge galvanized (unless otherwise noted).

   c. Insulation: Minimum 2" thick polyurethane foam in place insulation (CFC free).

d. Drain: Provide with 1" stainless steel drain

e. Control: Provide with on/off control to be filed installed.

C. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion and develop strength and corrosion resistance of base metal. Provide ductile welds free of mechanical imperfections such as gas holes, pits, or cracks.

1. Welded Butt Joints: Provide full-penetration welds for full-joint length. Make joints flat, continuous, and homogenous with sheet metal without relying on straps under seams, filling in with solder, or spot welding.

2. Grind exposed welded joints flush with adjoining material and polish to match adjoining surfaces.

3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and underpressed.

4. Coat unexposed stainless-steel welded joints with suitable metallic-based paint to prevent corrosion.

5. After zinc-coated steel is welded, clean welds and abraded areas and apply SSPCPaint 20, high-zinc-dust-content, galvanizing repair paint to comply with ASTM A 780.

D. Fabricate field-assembled equipment prepared for field-joining methods indicated. For metal butt joints, comply with referenced SMACNA standard, unless otherwise indicated.

E. Where stainless steel is joined to a dissimilar metal, use stainless-steel welding material or fastening devices.

F. Form metal with break bends that are not flaky, scaly, or cracked in appearance; where breaks mar uniform surface appearance of material, remove marks by grinding, polishing, and finishing.

G. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.

H. Provide surfaces in food zone, as defined in NSF 2, free from exposed fasteners.

I. Cap exposed fastener threads, including those inside cabinets, with stainless-steel lock washers and stainless-steel cap (acorn) nuts.

J. Provide pipe slots on equipment with turned-up edges and sized to accommodate service and utility lines and mechanical connections.

K. Provide enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices including those inside cabinets, unless otherwise indicated.

L. Seismic Restraints:

1. Fabricate to comply with referenced "SMACNA Guidelines for Seismic Restraint of Kitchen Equipment" in any State, province, or jurisdiction that has legislated this requirement as necessary for acceptance. This shall include:

    a. Identifying these items on his submittal drawings, Plans, Elevations, and Sections.

    b. Showing required SMACNA methods of restraint on his submittal drawings.

    c. Referencing the appropriate detail(s).

    d. Obtain regulatory approval for all seismic engineering details

2.4 FABRICATION, MILLWORK/CASEWORK

A. Fabricate food service equipment according to the "Manual of Millwork, current edition" of the Woodwork Institute, including all amended printed revisions, and NSF Standards. All composite wood products shall meet the latest California Air Resources Board (CARB) Composite Wood Products Regulations. Factory assemble equipment to greatest extent possible. All specially fabricated equipment must be by one manufacturer/fabricator per specialty acceptable to Consultant and the Owner.

B. Solid Surface Material (SSM) shall be Caesarstone, Silestone or approved equal and installed over 3/4" plywood per manufacturer's instructions. Provide air space, trim and /or insulation around any heat or cold producing equipment to guard against discoloration and cracking.

2.5 STAINLESS-STEEL FINISHES

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

    1. Remove or blend tool and die marks and stretch lines into finish.

    2. Grind and polish surfaces to produce uniform, directional textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

B. Concealed Surfaces: No. 2B finish (bright, cold-rolled, unpolished finish).

C. Exposed Surfaces: No. 4 finish (bright, directional polish).

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Unless expressly stipulated, and in a timely manner, no additional allowances will be made for Contractors or Manufacturers for errors, omissions or ambiguities not reported at time of bidding. Carefully review and compare the Contract Documents and at once report to Owner and/or Designer any errors, ambiguities, inconsistencies or omissions. Unless expressly stipulated, and in a timely manner, Kitchen Equipment Contractor shall be liable to Owner or Designer for any damage resulting from such errors, inconsistencies or omissions in the Contract Documents. Work shall not be done without approved Drawings, Specifications and/or Modifications and without receiving prior written receiving authorizations from Owner or Designer. Drawings and equipment specifications are intended to complement each other. Therefore, neither should be considered complete without the others.

B. Examine areas and conditions, with Installer present, for compliance with requirements or installation tolerances, service-utility connections, and other conditions affecting installation and performance of food service equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. Examine roughing-in for piping, mechanical, and electrical systems to verify actual locations of connections before installation.

D. Verify all conditions at the building, particularly door openings and passageways for large equipment. Coordinate with General Contractor access to insure delivery of equipment to the required areas. Coordination shall include, but not be limited to, early delivery, hoisting, window removal and/or delay of wall construction. All special equipment, handling charges, window removal, etc. shall be paid for by the Food Service Equipment Contractor.

E. Any and all food service equipment and equipment systems noted as “by owner/operator”, “by purveyor”, or “existing” in the food service construction documents are presented for reference only. These representations must be verified in writing by the food service equipment contractor, owner, operator, and/or general contractor prior to the release of “for construction” documentation. It will be the general contractor’s responsibility to further verify and coordinate all necessary information pertaining to this equipment or systems making up, or relating to, this equipment including, but not limited to, local health department regulations, local sanitation code requirements, mechanical, structural, plumbing and electrical requirements prior to commencement of construction. Consultant or Architect take no responsibility for design, intent, function, performance, utility requirements, or code compliance of non-specified equipment.

3.2 INSTALLATION, GENERAL

A. Install food service equipment level and plumb, according to manufacturer's written instructions, original design, and referenced standards.

B. Complete equipment field assembly, where required, using methods indicated.

1. Provide closed butt and contact joints that do not require a filler.

2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in "Fabrication, General" Article.

C. Install equipment with access and maintenance clearances according to manufacturer's written instructions and requirements of authorities having jurisdiction.

D. Provide cutouts in equipment, neatly formed, where required to run service lines through equipment to make final connections. Cut holes and provide sleeves for pipes on equipment, for drains, electrical, plumbing, etc., as required for proper installation. Verify sizes with Owner on the following items before ordering or fabrication: steam pans, sheet pans, trays, glass and cup racks.

E. Except for mobile and adjustable-leg equipment, securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.

F. Install cabinets and similar equipment on concrete or masonry bases in a bed of sealant.

G. Install hoods to comply with NFPA 96 requirements and to remain free from vibration when operating.

H. Install seismic restraints according to referenced SMACNA standard.

I. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches (1200 mm) o.c. maximum.

J. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

K. Prohibit cold storage rooms from being used by any other trade for storage or work areas. Repair or cause replacement to any damaged areas on the interior of the cold storage rooms, if the damage was caused due to the cold storage rooms being used for storage or work areas.

3.3 PROTECTING

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, that ensure food service equipment is without damage or deterioration at the time of Substantial Completion.

3.4 COMMISSIONING

A. Startup Services: Engage factory-authorized service representatives to perform startup services for all equipment. Factory trained representative shall demonstrate and train Owner's maintenance and operations personnel as specified below.

1. Coordinate food service equipment startup with service-utility testing, balancing, and adjustments. Do not operate steam lines before they have been cleaned and sanitized. Provide demonstrations for both operations and maintenance personnel.

2. Remove protective coverings and clean and sanitize equipment, both inside and out, and re-lamp equipment with integral lighting. Where applicable, comply with manufacturer's written cleaning instructions.

3. Test each equipment item for proper operation. Repair or replace equipment that is defective in operation, including units that operate below required capacity or that operate with excessive noise or vibration.

4. Provide maintenance and proper operations training to both the client maintenance and operations staff.

5. Provide service parts manuals as well as maintenance manuals.

6. Provide a list of service agencies authorized by the manufacturer to service its equipment. The list must include the name and telephone number of the person to contact.

3.5 FOOD SERVICE EQUIPMENT SCHEDULE

ITEM # 1-01 AIR CURTAIN

Quantity: One (1)
Manufacturer: Mars Air Systems
Model: N236-1UA-TS

1. One (1) Model N236-1UA-TS Industrial NSF N2 Series Air Curtain, for 36" wide door, Unheated, (1) 1/2 HP motor, 115v/60/1-ph, Titanium Silver powder coated cabinet (Custom Production Color), cETLus, CE, NSF
2. One (1) 5-year warranty, standard
3. One (1) Options WITHOUT control panel
4. One (1) Options WITHOUT time delay
5. One (1) Model 99-014 Steel Mechanical Universal Surface-mounted Plunger/Roller Switch

ITEM # 1-02 EMPLOYEE LOCKERS ON CONCRETE CURB

Quantity: Three (3)
Manufacturer: NIFSEC

1. Three (3) Employee Lockers On Concrete Curb- NIFSEC, See Architectural Section

ITEM # 1-03 WALL CAPS

Quantity: Two (2)
Manufacturer: Custom
Model: STAINLESS STEEL

1. Two (2) Model STAINLESS STEEL (LOT) Provide 14 ga. stainless steel wall caps at 6'-6" in height. Stainless steel shall have a #4 finish. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 1-04 MOP SINK

Quantity: One (1)
Manufacturer: Advance Tabco
Model: 9-OP-28

1. One (1) Model 9-OP-28 Mop Sink, floor mounted, 33"W x 25"D x 10"H (overall), 28"W x 20" front-to-back x 6" deep (bowl size), free flow drain with 2" IPS outlet, stainless steel construction

ITEM # 1-05 JANITOR'S SINK FAUCET W/VACUUM BREAKER

Quantity: One (1)
Manufacturer: T&S Brass
Model: B-0655-01

1. One (1) Model B-0655-01 Service Sink Faucet, vacuum breaker nozzle with 3/4" garden hose thread, 1/2" NPT female flanged adjustable inlet with screwdriver stops, 6" wrist action handles, pail hook, bottom support, wall brace
2. One (1) 6" wrist action handle, standard, nc

ITEM # 1-06 WALL SHELF (KNIFE BRACKETS)

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 3'-0" l x 1"-0" w. Provide stainless steel wall shelf with knife brackets. Wall shelf shall be: 18 ga stainless steel with #4 finish, bracket shall be 14 ga stainless steel. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 1-07 MOP HOLDER

Quantity: One (1)
Manufacturer: Advance Tabco
Model: K-242

1. One (1) Model K-242 Mop Hanger, 23", accommodates (3)

ITEM # 1-08 BUMPER RAILS

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL (LOT) Approximately 12'-4" l. Provide 14 ga. stainless steel bumper rails guards mounted at 34" above the finished floor. Stainless steel shall have a #4 finish. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 1-09 SPARE NO.

ITEM # 1-10 SPARE NO.

ITEM # 1-11 ICE CUBER

Quantity: One (1)
Manufacturer: Scotsman
Model: C1030SA-32

1. One (1) Model C1030SA-32 Prodigy Plus® Ice Maker, cube style, air-cooled, self-contained condenser, production capacity up to 1077 lb/24 hours at 70°/50° (844 lb AHRI certified at 90°/70°), stainless steel finish, small cube size, 208-230v/60/1-ph, 16.0 amps, cULus, NSF, CE, ENERGY STAR®
2. One (1) 3 year parts & labor warranties
3. One (1) 5 year parts & labor warranties on Evaporator
4. One (1) 5 year parts on compressor & condenser
5. One (1) Model KVS Prodigy™ Vari-Smart™ Ice Level Control, program ice bin levels to match ice needs (field install only)

ITEM # 1-12 ICE BIN FOR ICE MACHINES

Quantity: One (1)
Manufacturer: Scotsman
Model: B530S

1. One (1) Model B530S Ice Bin, top-hinged front-opening door, AHRI certified to 420 lb ice storage capacity, for top-mounted ice maker, polyethylene liner, metallic finish exterior, includes 6" legs, NSF
2. One (1) 3 year parts & labor warranties

ITEM # 1-13 FLOOR TROUGH

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 2'-6" l x 1'-0" d. Provide stainless steel floor trough, and stainless steel trough box with #4 finish. Provide IMC Teddy ASFT-ADA stainless steel accessible grating. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 1-14 WATER FILTRATION SYSTEM

Quantity: One (1)

Manufacturer: Scotsman
Model: SSM2-P

1. One (1) Model SSM2-P Water Filter Assembly, twin system, designed for ice makers & beverage equipment, cubers over 650 lb, & up to 1200 lb, flakers & nuggets over 1200 lb, includes AquaArmor by AgION for antimicrobial protection, NSF, cULus

ITEM # 1-15 DRY SHELVING UNITS

Quantity: Seven (7)
Manufacturer: Cambro
Model: CAMSHELVING

1. Seven (7) Model CAMSHELVING (LOT) 4 tier, 21" deep shelving units, posts to be 72" high, shelving units shall have a smooth surface without any welding or crevices. Posts and traverses shall be made of steel metal core with thick polypropylene covers. Shelf plates shall have a smooth surface without any welding or crevices, be of a structural web design and removable to be washed manually or in a commercial dishwasher. Shelf plates shall contain CamGuard, antimicrobial that inhibits the growth of mold, fungus and bacteria. Posts shall have dovetails that allow shelves to be adjusted in 4" increments. Provide dunnage stands for all traverses 54" or longer and at corners where corner connectors are used. Verify evaporator coil location, shelving units below coil to have 3 shelves. Provide in the configuration shown on plans, verify final sizes of shelves and posts by field measuring prior to ordering.

ITEM # 1-16 REACH-IN FREEZER

Quantity: One (1)
Manufacturer: Victory Refrigeration
Model: FS-1D-S1

1. One (1) Model FS-1D-S1 UltraSpec Series Freezer Featuring Secure-Temp 1.0™ Technology, Reach-in, one-section, self-contained refrigeration, 21.5 cu. ft. capacity, (1) full height hinged solid door, (3) silver freeze (chrome-style) shelves, stainless exterior & interior, standard depth cabinet, V-TEMP electronic temperature control/indicator, LED lighting, expansion valve technology, Santoprene door gaskets with 2 year warranty, stainless steel breakers, 1/3 HP, UL, cUL, UL EPH Classified, MADE IN USA
2. One (1) 3 years parts & labor warranty (excludes maintenance items)
3. One (1) Self-Contained refrigeration
4. One (1) Additional 2 year compressor warranty, standard
5. One (1) 115v/60/1-ph, 8.5 amps, 5-15P cord & plug, standard
6. One (1) Door hinging: on left at factory
7. One (1) Model 00C31-055A 6" Seismic Legs
8. One (1) Provide unit with condensate evaporator.

ITEM # 1-17 REACH-IN REFRIGERATOR

Quantity: One (1)
Manufacturer: Victory Refrigeration
Model: RS-2D-S1

1. One (1) Model RS-2D-S1 UltraSpec Series Refrigerator Featuring Secure-Temp 1.0™ Technology, Reach-in, two-section, self-contained refrigeration, 46.5 cu. ft. capacity, (2) full height hinged solid doors, (6) epoxy coated shelves, stainless steel exterior & interior, standard depth cabinet, V-TEMP electronic temperature control/indicator, LED lighting, expansion valve technology, Santoprene door gaskets with 2 year warranty, stainless steel breakers, 1/3 HP, UL, cUL, UL EPH Classified, MADE IN USA
2. One (1) 3 years parts & labor warranty (excludes maintenance items)
3. One (1) Self-Contained refrigeration
4. One (1) Additional 2 year compressor warranty, standard
5. One (1) 115v/60/1-ph, 10.7 amps w/cord & plug, standard
6. One (1) Door hinging: left door hinged on left, right door hinged on right standard
7. One (1) Model 00C31-055A 6" Seismic Legs

ITEM # 1-18 SPARE NO.

ITEM # 1-19 SPLASH MOUNTED 10" FAUCET

Quantity: One (1)
Manufacturer: T&S Brass
Model: B-2429-CR

1. One (1) Model B-2429-CR 8"c/c Wall Mount Faucet,1/2"NPT Female Inlets,Ceramic Cartridges,10"Swing Nozzle
2. One (1) Model B-0199-01F-20 Aerator, non-splash, flow control, 2.0 gpm, 55/64"-27 UNS female threads

ITEM # 1-20 WORK TABLE W/ HAND & PREP SINK

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 16'-0" l x 2'-6" w. Provide stainless steel work table with 1-5/8" legs with adjustable flanged feet, lower and/or mid shelves, 6" high back and end splash. Top shall be 14 ga stainless steel, and legs shall be 16 ga. Fabricate and install per complete drawings, schedules, elevations, and details.

2. One (1) CSS Model HAND SINK Provide 16 ga stainless steel sink tub measuring approximately 10" w x 14" d x 7" h. Welded in place with polished seams and left side splash. Provide with T&S basket strainer.
3. One (1) CSS Model PREP SINK Provide 16 ga stainless steel sink tub measuring approximately 18" w x 18" d x 12" h. Welded in place with polished seams.
4. One (1) Fisher Model 29033 DrainKing Waste Valve, flat strainer, overflow body, chrome finish

ITEM # 1-21 HAND SINK FAUCET, 4" CENTER, DECK MOUNT

Quantity: One (1)
Manufacturer: T&S Brass
Model: B-0325-CR

1. One (1) Model B-0325-CR Pantry Faucet, double, 4" c/c, swivel gooseneck, lever handles, 00AA inlets & ceramas

ITEM # 1-22 SOAP AND TOWEL DISPENSER

Quantity: One (1)
Manufacturer: NIFSEC
Model: BY CONTRACTOR

1. One (1) Model BY CONTRACTOR Soap and Towel Dispenser - NIFSEC, By Contractor, See Architectural Section

ITEM # 1-23 TRASH RECEPTACLE W/DOLLY

Quantity: One (1)
Manufacturer: Rubbermaid
Model: FG262000GRAY

1. One (1) Model FG262000GRAY ProSave® BRUTE® Container, without lid, 20 gallon, 19-1/2"D x 22-7/8"H, round, reinforced rims, built in handles, double rimmed base, high-impact plastic construction, gray, NSF
2. One (1) All-plastic, professional-grade construction will not rust, chip or peel; resists dents.
3. One (1) Reinforced rims add strength and durability
4. One (1) Built-in handles allow easy, non-slip lifting and anti-jam nesting
5. One (1) Double-ribbed base increases stability and dragging capacity
6. One (1) USDA Meat & Poulty Equipment Group listed and assist in complying with HACCP guidelines.
7. One (1) Certified to NSF Standard #2 and Standard #21
8. One (1) Model FG264043BLA BRUTE® Quiet Dolly, 18-1/4"D x 6-5/8"H, non-marking blue casters, black

ITEM # 1-24 WALL SHELF (KNIFE BRACKETS)

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 14'-0" l x 1"-0" w. Provide stainless steel wall shelf with knife brackets. Wall shelf shall be: 18 ga stainless steel with #4 finish, bracket shall be 14 ga stainless steel. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 1-25 SPLASH MOUNTED HI-FLO UTENSIL SINK FAUCET

Quantity: Two (2)
Manufacturer: T&S Brass
Model: B-0291

1. Two (2) Model B-0291 Kettle & Pot Sink Faucet, Big-Flo, wall mounted 8" centers, 3/4" IPS model LL street EL inlets with locknuts, 18" swing nozzle, 175°F four arm handles, 1-1/4" diameter holes required in backsplash

ITEM # 1-26 3 COMPARTMENT POT SINK

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 7'-6" l x 2'-6" w. Provide stainless steel pot sink assembly with 1-5/8" legs with adjustable flanged feet, lower and/or mid shelves, 8" high back and end splash. Top shall be 14 ga stainless steel, and legs shall be 16 ga. Fabricate and install per complete drawings, schedules, elevations, and details.
2. Three (3) CSS Model SINKS Provide 16 ga stainless steel sink tub measuring approximately 18" w x 26" d x 14" h. Welded in place with polished seams.
3. Three (3) Fisher Model 29033 DrainKing Waste Valve, flat strainer, overflow body, chrome finish

ITEM # 1-27 WALL SHELF (KNIFE BRACKETS)

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 1'-6" l x 1"-0" w. Provide stainless steel wall shelf with knife brackets. Wall shelf shall be: 18 ga stainless steel with #4 finish, bracket shall be 14 ga stainless steel. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 1-28 UTENSIL RACK

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 4'-8" l x 1/4" w x 2" d. Provide stainless steel flatbar utensil rack with sliding hooks 8" on center. Stainless steel shall #4 finish. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 1-29 WALL SHELF (KNIFE BRACKETS)

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 1'-6" l x 1"-0" w. Provide stainless steel wall shelf with knife brackets. Wall shelf shall be: 18 ga stainless steel with #4 finish, bracket shall be 14 ga stainless steel. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 1-30 CHEMICAL STORAGE SHELVING UNITS

Quantity: One (1)
Manufacturer: Cambro
Model: CAMSHELVING

1. One (1) Model CAMSHELVING (LOT) 4 tier, 21" deep shelving units, posts to be 72" high, shelving units shall have a smooth surface without any welding or crevices. Posts and traverses shall be made of steel metal core with thick polypropylene covers. Shelf plates shall have a smooth surface without any welding or crevices, be of a structural web design and removable to be washed manually or in a commercial dishwasher. Shelf plates shall contain CamGuard, antimicrobial that inhibits the growth of mold, fungus and bacteria. Posts shall have dovetails that allow shelves to be adjusted in 4" increments. Provide dunnage stands for all traverses 54" or longer and at corners where corner connectors are used. Provide in the configuration shown on plans, verify final sizes of shelves and posts by field measuring prior to ordering.

ITEM # 1-31 EXHAUST HOOD

Quantity: One (1)
Manufacturer: Halton
Model: EO

1. One (1) Model EO Exhaust hood 5'-0" l x 4'-0" w x 2'-0" h to be constructed from 18 gauge stainless steel with brushed satin finish. The hoods shall be supplied complete with outer casing/main body, inner liner, exhaust duct, incandescent lighting, grease filters, perimeter drain channel, collection cup, and assembly brackets. Each joint shall be welded and liquid tight. All

exposed welds are ground and polished to the original finish of metal. Hood is also equipped with a collection cup or a draining tap is fitted into the grease drain channel to enable the removal of the grease and contaminants extracted by the stainless steel filters. Canopy ends shall be double sided wall construction (no single wall hoods permitted). Each hood can be provided with surface mount light fixture(s). The lighting shall be suitable for single-phase power supply and shall be UL listed incandescent type, suitable for condensate hoods. Fluorescent light fixtures are offered as an option. The hood shall be equipped with aluminum baffle type grease filters. The grease extractors shall be UL classified and mounted in the full length filter bank with concealed grease channel. The filter are easily removed via two folding handles

ITEM # 1-32 EXHAUST HOOD TRIM AND CLOSURE PANEL

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 5'-0" l x 4'-0" w. Provide 18 ga stainless steel exhaust hood trim and closure panels with #4 finish. Provide all necessary closure, louvers and trim strips for a complete installation. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 1-33 FIRE PROTECTION SYSTEM

Quantity: One (1)
Manufacturer: Ansul Fire Protection
Model: R102

1. One (1) Model R102 Provide One (1) each Fire Protection System complete with nozzles, fusible links, piping, pull box, and actuators, utilizing a wet chemical extinguishing agent fabricated and installed by an approved Ansul system installer. Provide in accordance with complete drawings, details, and specifications section 114000. System to be an R-102 automatic type and be manufactured and installed per the current NFPA guidelines and be U.L. approved. Cylinders shall be mounted on wall in a stainless steel enclosure, or mounted in a stainless steel cabinet attached to the exhaust hood. All piping to be concealed with the exception of drops which shall be chrome sleeved and of as minimal exposure as possible. Size, number, and location of nozzles or fusible links to be in accordance with U.L. limits for this particular system. Fire system contractor shall provide engineered drawings, acquire permit, coordinate start-up and testing with the appropriate Fire Officials, and obtain final certification. Provide as-built drawings at completion of install. Fire System installer to provide adequate job site visits to coordinate installation of un-exposed pipe and installation of system. Include the appropriately sized and approved electronic gas shut-off valve(s).

ITEM # 1-34 FIRE PULL BOX

Quantity: One (1)
Manufacturer: Custom
Model: PART OF ITEM #1-33

1. One (1) Model PART OF ITEM #1-33 Fire Pull Box - Box by electrician, Mechanism part of item #1-33 Fire Protection System.

ITEM # 1-35 CLASS K FIRE EXTINGUISHER

Quantity: One (1)
Manufacturer: NIFSEC
Model: SEE ARCH. SECT

1. One (1) Model SEE ARCH. SECT Class K Fire Extinguisher - NIFSEC, See Architectural Section.

ITEM # 1-36 WORK TABLE

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 2'-0" l x 3'-4" w. Provide stainless steel work table with 1-5/8" legs with adjustable flanged feet, lower and/or mid shelves, 6" high back and end splash. Top shall be 14 ga stainless steel, and legs shall be 16 ga. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 1-37 RANGE, 36", 6 OPEN BURNERS

Quantity: One (1)
Manufacturer: Vulcan
Model: SX36-6B

1. One (1) Model SX36-6B SX Series Restaurant Range, gas, 36", (6) 28,000 BTU burners with lift-off burner heads, standard oven, stainless steel front, sides, backriser & lift-off high shelf, 6" adjustable legs, 198,000 BTU, ETL-Sanitation
2. One (1) 1 year limited parts and labor warranty, standard
3. One (1) Natural gas (add suffix "N")(specify elevation if over 2,000 ft.)
4. One (1) Dormont Model 1675KITCF2S48 Dormont Blue Hose™ Moveable Gas Connector Kit, 3/4" inside dia., 48" long covered with stainless steel braid, coated with blue antimicrobial PVC,

1 Safety Quik® QDV, 2 Swivel MAX®, and coiled restraining cable with hardware, 160,000 BTU/hr minimum flow capacity, limited lifetime warranty

ITEM # 1-38 WALL FLASHING

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL (LOT) Approximately 5'-0" l. Provide 20 ga. stainless steel wall flashing from floor to exhaust hood with #4 finish. Provide all necessary closure and trim strips for a complete installation. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 2-01 COFFEE GRINDER

Quantity: Two (2)
Manufacturer: NIFSEC

1. Two (2) Coffee Grinder - NIFSEC

ITEM # 2-02 COFFEE BREWER

Quantity: One (1)
Manufacturer: NIFSEC

1. One (1) Coffee Brewer - NIFSEC

ITEM # 2-03 SPARE NO.

ITEM # 2-04 WORK COUNTER W/ PREP SINK ASSEMBLY

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 12'-6" l x 2'-9" w. Provide stainless steel work counter with undershelf and/or mid shelf, galvanized metal base, and 6" high back and end splash. Top shall be 14 ga stainless steel, body to be 16 ga. Fabricate and install per complete drawings, schedules, elevations, and details.
2. One (1) CSS Model PREP SINK Provide 16 ga stainless steel sink tub measuring approximately 18" w x 18" d x 12" h. Welded in place with polished seams.
3. One (1) Fisher Model 29033 DrainKing Waste Valve, flat strainer, overflow body, chrome finish

ITEM # 2-05 HAND SINK FAUCET, 4" CENTER, DECK MOUNT

Quantity: One (1)
Manufacturer: T&S Brass
Model: B-0325-CR

1. One (1) Model B-0325-CR Pantry Faucet, double, 4" c/c, swivel gooseneck, lever handles, 00AA inlets & ceramas cartridges.

ITEM # 2-06 SPLASH MOUNTED 10" FAUCET

Quantity: One (1)
Manufacturer: T&S Brass
Model: B-2429-CR

1. One (1) Model B-2429-CR 8"c/c Wall Mount Faucet,1/2"NPT Female Inlets,Ceramic Cartridges,10"Swing Nozzle
2. One (1) Model B-0199-01F-20 Aerator, non-splash, flow control, 2.0 gpm, 55/64"-27 UNS female threads

ITEM # 2-07 HOT FOOD WELL UNIT, DROP-IN, ELECTRIC

Quantity: Two (2)
Manufacturer: Hatco
Model: HWBH-11QTD

1. Two (2) Model HWBH-11QTD Drop-In Heated Well, round, with drain, 11 quart, top mounted, remote thermostat with separate power switch, stainless steel construction (high wattage), Made in USA
2. Two (2) One year on-site parts and labor warranty, plus one additional year parts only warranty on the metal sheathed elements
3. Two (2) 120v/60/1, 800w, 6.7 amps
4. Two (2) Compact profile front-mounted thermostatic control with lighted on/off rocker switch and decorative bezel
5. Two (2) EZ locking hardware standard
6. Two (2) Model BALLVALVE3/4 High Temperature NPT Ball Valve, 3/4", for units with drains and no manifold
7. Two (2) Model 11QT-PAN 11 Quart round pan, stainless steel
8. Two (2) Model 11QT-LID Lid, round hinged and notched, 11 quart

ITEM # 2-08 HAND SINK

Quantity: One (1)
Manufacturer: IMC/Teddy
Model: ADA-WSX

1. One (1) Model ADA-WSX Handicap Hand Sink, wall mount, 14" wide x 16" front-to-back x 4" deep bowl, 10"H integrated backsplash, non-drip marine edge on front & sides, integral apron conceals plumbing, 16/304 stainless steel, ADA, NSF
2. One (1) Model ITD Integrated Towel Dispenser (built in to apron)
3. One (1) Model SD Soap Dispenser, integral deck mounted, stainless steel construction, 20oz capacity
4. Two (2) Model SS Side Splashes for hand sink (pair)

ITEM # 2-09 MICROWAVE CONVECTION / IMPINGEMENT OVEN

Quantity: Two (2)
Manufacturer: Turbochef
Model: I3-9500-01

1. Two (2) Model I3 I3™ Convection/Microwave Oven, Rapid Cook, electric, 23" wide, ventless, countertop, fully insulated cook chamber, stores up to 200 recipes, internal catalytic converter, smart voltage sensor technology (US only), digital display, removable rack and grease collection pan, top and bottom jet plates, pull down door with ergonmic handle, multi-speed convection blower, (2) solid PTFE baskets, (1) oven cleaner, (1) oven guard, (1) aluminum paddle, (2) trigger sprayers, (1) standard rack, side hand grips, stainless steel front, top & sides, cULus, CE, UL-EPH Classified, ANSI/NSF 4, TUV
2. Two (2) All items FOB: Carrollton, Texas: Consumable/accessory orders less than $5,000 will incur a handling fee. Orders shipping standard ground will incur a $15.00 handling fee. Orders shipping other than standard ground will incur $25.00 handling fee
3. Two (2) One year parts and labor warranty
4. Two (2) 208-240v/60/1-ph, 40.0amps, 8.3-9.6kw, 6 foot cord (nominal), NEMA 6-50P, standard

ITEM # 2-10 REACH-IN UNDERCOUNTER FREEZER

Quantity: One (1)
Manufacturer: Beverage Air
Model: UCF27A

1. One (1) Model UCF27A Undercounter Freezer, one-section, 27" W, 7.3 cu. ft., (1) door, (2) shelves, stainless steel top with turned down edges, stainless steel exterior, aluminum interior, rear-mounted self-contained refrigeration, 6" casters, 1/4 hp, UL, cUL, UL EPH, MADE IN USA
2. One (1) 3 years parts & labor warranty (excludes maintenance items)
3. One (1) Self-contained refrigeration standard
4. One (1) Additional 2 yr compressor warranty, standard
5. One (1) 115v/60/1-ph, 6.0 amps, standard
6. One (1) Door hinged on left
7. One (1) 2-3/4" Casters, low profile, in lieu of standard 6" heavy duty casters, no charge when specified on order

ITEM # 2-11 SPARE NO.

ITEM # 2-12 INSULATED ICE BIN STORAGE BIN

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Provide 14 ga. stainless steel ice storage bin with #4 finish. Provide all necessary closure, louvers and trim strips for a complete installation. Insulation shall be polyurethane. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 2-13 BLENDER, BAR

Quantity: Two (2)
Manufacturer: Vitamix
Model: 36019

1. Two (2) Model 36019 The Quiet One® Blender, countertop, 48 oz. (1.4 liter) capacity clear Advance® container, 24-1/2" H with lid open, stackable, removable compact cover, (6) touch control buttons with 34 program option, includes: Advance® blade assembly & lid, 3-peak HP, RoHs compliant, CE, cULus, NSF
2. Two (2) 3 years warranty on motor base parts & 1 year warranty on labor, standard
3. Two (2) 120v/50-60/1-ph, 15 amps, standard

ITEM # 2-14 DROP-IN 12X20 HOTEL PAN <NIC>

Quantity: One (1)
Manufacturer: NIFSEC

1. One (1) Drop-in 12x20 Hotel Pan - NIFSEC

ITEM # 2-15 COLD FOOD WELL UNIT, DROP-IN, REFRIGERATED

Quantity: One (1)
Manufacturer: Vollrath
Model: 36456

1. One (1) Model 36456 NSF7 Refrigerated Cold Pan, drop-In, 1-pan, 6-5/8" deep well, accommodates standard 12" x 20" pan with adaptor bars, drip-free flange, polyurethane foam insulated, 18/8 stainless steel, 18 gauge galvanized exterior housing, self contained refrigeration, 1/5 HP, 120v/60/1-ph, cord with NEMA 5-15P, 3.8 amps, cULus, NSF, Made in USA (lead time 3-5 business days plus day for order entry)

ITEM # 2-16 SNEEZEGUARD WITH PASS SHELF

Quantity: One (1)
Manufacturer: BSI
Model: ZG9915

1. One (1) Model ZG9915 Zguard: 24" --- Includes (2) ZGUARD 9915 Adjustable Cantilevered w/ Top Shelf Series End Post(s) S/S Post #4 Finish, Brushed ALUMINUM Bracket Finish, 3/8" tempered glass front panels and 3/8" topshelves, BSI LED lights installed in a slim-line housing, wiring and installation by others in the field., ZGuard Mounting Method MWU5- Below Counter Mount Heavy Duty Flange - Sufficient sub structure as well as access below counter is required when using this under counter mount., Unit shipped fully assembled. , (108) # shipping weight each. Does not include Heat Lamps or Lights

ITEM # 2-17 DIPPER WELL

Quantity: One (1)
Manufacturer: T&S Brass
Model: B-2282-01-F05

1. One (1) Model B-2282-01-F05 Dipper Well Faucet, with drain, stainless steel bowl, removable inner overflow cup, 0.5 gpm flow control, brass knob, polish chrome plated

ITEM # 2-18 SERVICE COUNTER

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL / MILLWORK

1. One (1) Model STAINLESS STEEL / MILLWORK Approximately 21'-6" l x 3'-0" w. Provide stainless steel undercounter with stone top, stainless steel intermediate and/or lower shelves, galvanized metal base, millwork die front with hardwood veneer or high pressure laminate finish. See finish schedule for specific finish requirements. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 2-19 SPARE NO.

ITEM # 2-20 SPARE NO.

ITEM # 2-21 ESPRESSO MACHINE

Quantity: Two (2)
Manufacturer: NIFSEC

1. Two (2) Espresso Machine - NIFSEC

ITEM # 2-22 REACH-IN UNDERCOUNTER REFRIGERATOR

Quantity: One (1)

Manufacturer: Beverage Air
Model: UCR48A

1. One (1) Model UCR48A Undercounter Refrigerator, two-section, 48" W, 13.9 cu. ft., (2) doors, (4) shelves, stainless steel exterior & top, aluminum interior, rear-mounted self-contained refrigeration, 6" casters, 1/5 hp, UL, cUL, UL EPH, MADE IN USA
2. One (1) 3 years parts & labor warranty (excludes maintenance items)
3. One (1) Self-contained refrigeration standard
4. One (1) Additional 2 yr compressor warranty, standard
5. One (1) 115v/60/1-ph, 3.3 amps, 8' cord, NEMA 5-15P, standard
6. One (1) Left door hinged left, right door hinged on right, standard
7. One (1) 2-3/4" Casters, low profile, in lieu of standard 6" heavy duty casters, no charge when specified on order

ITEM # 2-23 CASH REGISTER <NIC>

Quantity: Two (2)
Manufacturer: NIFSEC

1. Two (2) Cash Register - NIFSEC

ITEM # 2-24 SERVICE/SELF-SERVICE COMBO MERCHANDISER

Quantity: One (1)
Manufacturer: Structural Concepts
Model: HOU3852R

1. One (1) Model HOU3852R Encore® Service/Self-Service Combo Merchandiser, 40"W, upper: curved lift-up front glass, clear glass rear sliding doors without lock, lighted glass shelf in upper display (non-divided), convertible refrigeration, lower: open self-service refrigerated, top light, sheet metal deck, black interior, black trim, (2) cutaway end panels with mirror, Breeze™ with EnergyWise self-contained refrigeration system, cETLus, ETL-Sanitation
2. One (1) NOTE: If GFCI is required, a GFCI breaker MUST be used in lieu of a GFCI receptacle
3. One (1) NOTE: 43" minimum entry door clearance required (with out shipping skid)
4. One (1) 1 yr. parts & labor warranty, 5 yr. compressor warranty, standard
5. One (1) Extended second year parts & labor warranty (excluding compressor) at time of order
6. One (1) Slide out self-contained refrigeration system, standard
7. One (1) 110-120v/60/1ph, 12.0 amps, standard
8. One (1) 6 ft straight blade power cord with NEMA 5-15P, standard
9. One (1) NOTE: Compressor air intake from rear & out-front panel, front panel cannot be blocked (Not applicable with remote refrigeration option)
10. One (1) Base Support: Casters (not available with remote refrigeration)
11. One (1) Exterior: Wilsonart or Formica NON-PREMIUM laminate (Color chart available from factory rep or access color selections via www.wilsonart.com or www.formica.com)
12. One (1) NOTE: SCC will not be responsible for additional charges incurred for Premium or other Manufacturer's laminate selections not originally quoted
13. One (1) Rear Exterior: White, standard
14. One (1) Trim: Black, standard

15. One (1) Upper Rear: Clear glass rear sliding doors, standard
16. One (1) Night curtain, retractable, non-locking
17. One (1) Digital Fahrenheit thermometer, standard
18. One (1) Verify finishes with architect.
19. One (1) Model FINISH Florence Walnut from Wilsonart (Horizontal Grain Direction)

ITEM # 3-01 FILLER PANELS AND TRIM

Quantity: Two (2)
Manufacturer: Custom
Model: STAINLESS STEEL

1. Two (2) Model STAINLESS STEEL Provide 14 ga. stainless steel filler panel with #4 finish. Provide all necessary closure, louvers and trim strips for a complete installation. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 3-02 FREEZER MERCHANDISER

Quantity: One (1)
Manufacturer: True Food Service Equipment
Model: GDM-23F-HC~TSL01

1. One (1) Model GDM-23F-HC~TSL01 Freezer Merchandiser, one-section, True standard look version 01, -10° F, (4) shelves, powder coated exterior, white interior with stainless steel floor, (1) triple-pane thermal glass hinged door, LED interior lights, R290 Hydrocarbon refrigerant, 1 HP, 115v/60/1-ph, 9.3 amps, NEMA 5-15P, cULus, UL EPH Classified, MADE IN USA, ENERGY STAR®
2. One (1) Self-contained refrigeration standard
3. One (1) Warranty - 5 year compressor (self-contained only), please visit www.Truemfg.com for specifics
4. One (1) Warranty - 3 year parts and labor, please visit www.Truemfg.com for specifics
5. One (1) Left door hinging
6. One (1) Exterior: Stainless steel
7. One (1) Interior: Stainless steel, upcharge & lead time will apply
8. One (1) Model S-SNC Sign, "No Copy(Blank)" silver graphic in lieu of standard
9. One (1) Seismic/flanged legs, 6", set of 4

ITEM # 3-03 REFRIGERATED MERCHANDISER

Quantity: Two (2)
Manufacturer: True Food Service Equipment
Model: GDM-49-HC~TSL01

1. Two (2) Model GDM-49-HC~TSL01 Refrigerated Merchandiser, two-section, True standard look version 01, (8) shelves, powder coated exterior, white interior with stainless steel floor, (2) double pane thermal insulated glass hinged doors, LED interior lights, R290 Hydrocarbon refrigerant, 1/2 HP, 115v/60/1, 8.5 amps, NEMA 5-15P, cULus, UL EPH Classified, MADE IN USA, ENERGY STAR®
2. Two (2) Self-contained refrigeration standard
3. Two (2) Warranty - 5 year compressor (self-contained only), please visit www.Truemfg.com for specifics
4. Two (2) Warranty - 3 year parts and labor, please visit www.Truemfg.com for specifics
5. Two (2) Left door hinged left, right door hinged right standard
6. Two (2) Exterior: Stainless steel
7. Two (2) Interior: Stainless steel, upcharge & lead time will apply
8. Two (2) Model S-SNC Sign, "No Copy(Blank)" silver graphic in lieu of standard
9. Two (2) Seismic/flanged legs, 6", set of 4

ITEM # 3-04 SELF-SERVICE REFRIGERATED MERCHANDISER

Quantity: One (1)
Manufacturer: Structural Concepts
Model: B8832

1. One (1) Model B8832 Oasis® Self-Service Refrigerated Merchandiser, 88-3/8"W, high profile, open front, (4) non-lighted shelves, top light, Breeze-E (Type ll) with EnergyWise self-contained refrigeration system, Blue Fin coated coil, black interior, full end panels with mirror, cETLus, ETL-Sanitation
2. One (1) NOTE: If GFCI is required, a GFCI breaker MUST be used in lieu of a GFCI receptacle
3. One (1) 1 yr. parts & labor warranty, 5 yr. compressor warranty, standard
4. One (1) Extended second year parts & labor warranty (excluding compressor) at time of order
5. One (1) Breeze-E (Type II) with EnergyWise self-contained refrigeration, lower front air intake/upper front air discharge, standard
6. One (1) 208-240v/60/1ph, 20.38 amps, standard
7. One (1) 6 ft straight blade power cord NEMA 6-30P (base exit), standard
8. One (1) NOTE: Compressor air intake through lower front & channeled up rear & out upper front, front panel cannot be blocked
9. One (1) Base Support: Casters, with levelers, standard
10. One (1) Exterior: Wilsonart or Formica NON-PREMIUM laminate (Color chart available from factory rep or access color selections via www.wilsonart.com or www.formica.com)
11. One (1) NOTE: SCC will not be responsible for additional charges incurred for Premium or other Manufacturer's laminate selections not originally quoted
12. One (1) Lower front panel: Black, standard
13. One (1) Left end panel: Full with mirrored interior, metal edging, standard
14. One (1) Right end panel: Full with mirrored interior, metal edging, standard

15. One (1) Add Lights (LED) to standard shelves (4)
16. One (1) Night curtain: Retractable, non-locking
17. One (1) Add Lights (LED 4200K) to standard shelves (4)
18. One (1) Verify Finishes with architect.
19. One (1) Model FINISH Florence Walnut from Wilsonart (Horizontal Grain Direction)

ITEM # 4-01 AIR CURTAIN

Quantity: One (1)
Manufacturer: Mars Air Systems
Model: NH242-1UA-TS

1. One (1) Model NH242-1UA-TS High Velocity Series 2 Air Curtain, for NSF Certified 42" wide door, Unheated, 115v/60/1-ph, Titanium Silver powder coated cabinet (Standard Production Color) cETLus, CE, NSF, Dimensions 14.00(h) x 42.00(w) x 15.62(d)
2. One (1) 5 year warranty, standard
3. One (1) Options WITHOUT control panel
4. One (1) Options WITHOUT time delay
5. One (1) 99-014 Steel Mechanical Universal Surface-mounted Plunger/Roller Switch

ITEM # 4-02 HAND SINK

Quantity: One (1)
Manufacturer: IMC/Teddy
Model: ADA-WSX

1. One (1) Model ADA-WSX Handicap Hand Sink, wall mount, 14" wide x 16" front-to-back x 4" deep bowl, 10"H integrated backsplash, non-drip marine edge on front & sides, integral apron conceals plumbing, 16/304 stainless steel, ADA, NSF
2. One (1) Model ITD Integrated Towel Dispenser (built in to apron)
3. One (1) Model SD Soap Dispenser, integral deck mounted, stainless steel construction, 20oz capacity

ITEM # 4-03 PANTRY FAUCET

Quantity: One (1)
Manufacturer: T&S Brass
Model: B-0325-CR

1. One (1) Model B-0325-CR Pantry Faucet, double, 4" c/c, swivel gooseneck, lever handles, 00AA inlets & ceramas cartridges.

ITEM # 4-04 REACH-IN REFRIGERATOR

Quantity: One (1)

Manufacturer: Victory Refrigeration
Model: RS-2D-S1

1. One (1) Model RS-2D-S1 UltraSpec Series Refrigerator Featuring Secure-Temp 1.0™ Technology, Reach-in, two-section, self-contained refrigeration, 46.5 cu. ft. capacity, (2) full height hinged solid doors, (6) epoxy coated shelves, stainless steel exterior & interior, standard depth cabinet, V-TEMP electronic temperature control/indicator, LED lighting, expansion valve technology, Santoprene door gaskets with 2 year warranty, stainless steel breakers, 1/3 HP, UL, cUL, UL EPH Classified, MADE IN USA
2. One (1) 3 years parts & labor warranty (excludes maintenance items)
3. One (1) Self-Contained refrigeration
4. One (1) Additional 2 year compressor warranty, standard
5. One (1) 115v/60/1-ph, 10.7 amps w/cord & plug, standard
6. One (1) Door hinging: left door hinged on left, right door hinged on right standard
7. One (1) Model 00C31-055A 6" Seismic Legs

ITEM # 4-05 MOP SINK

Quantity: One (1)
Manufacturer: Advance Tabco
Model: 9-OP-28

1. One (1) Model 9-OP-28 Mop Sink, floor mounted, 33"W x 25"D x 10"H (overall), 28"W x 20" front-to-back x 6" deep (bowl size), free flow drain with 2" IPS outlet, stainless steel construction

ITEM # 4-06 JANITOR'S SINK FAUCET W/VACUUM BREAKER

Quantity: One (1)
Manufacturer: T&S Brass
Model: B-0655-01

1. One (1) Model B-0655-01 Service Sink Faucet, vacuum breaker nozzle with 3/4" garden hose thread, 1/2" NPT female flanged adjustable inlet with screwdriver stops, 6" wrist action handles, pail hook, bottom support, wall brace
2. One (1) 6" wrist action handle, standard, nc

ITEM # 4-07 MOP HOLDER

Quantity: One (1)
Manufacturer: Advance Tabco
Model: K-242

1. One (1) Model K-242 Mop Hanger, 23", accommodates (3)

ITEM # 4-08 WALL CAPS

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL (LOT) Provide 14 ga. stainless steel wall caps at 6'-6" in height. Stainless steel shall have a #4 finish. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 4-09 SPARE NO.

ITEM # 4-10 CORNER GUARDS

Quantity: Three (3)
Manufacturer: Custom
Model: STAINLESS STEEL

1. Three (3) Model STAINLESS STEEL (LOT) Provide 14 ga. stainless steel corner guards at 6'-6" in height. Stainless steel shall have a #4 finish. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 4-11 WALL SHELF (KNIFE BRACKETS)

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 2'-9" l x 1"-0" w. Provide stainless steel wall shelf with knife brackets. Wall shelf shall be: 18 ga stainless steel with #4 finish, bracket shall be 14 ga stainless steel. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 4-12 MOBILE CART

Quantity: Four (4)
Manufacturer: NIFSEC

1. Four (4) Mobile Cart- NIFSEC, By Owner

ITEM # 4-13 BUMPER RAILS

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL (LOT) Approximately 27'-6" l. Provide 14 ga. stainless steel bumper rails guards mounted at 34" above the finished floor. Stainless steel shall have a #4 finish. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 4-14 WORK TABLE W/ GLASS FILL STATION

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 19'-0" l x 2'-6" w. Provide stainless steel work table with 1-5/8" legs with adjustable flanged feet, lower and/or mid shelves, 6" high back and end splash. Top shall be 14 ga stainless steel, and legs shall be 16 ga. Fabricate and install per complete drawings, schedules, elevations, and details.
2. One (1) CSS Model GLASS FILL SINK Provide 16 ga stainless steel sink tub with removable rack grate measuring approximately 20" w x 20" d x 14" h. Sink to be welded in place with polished seams. Removable rack gate to be 19 1/2" w x 19 1/2" d x 1/4" h square tubing, fully welded construction and welded 1/4" x 1/4" h round solid stainless steel rod feet.
3. One (1) Fisher Model 29033 DrainKing Waste Valve, flat strainer, overflow body, chrome finish

ITEM # 4-15 UNDER COUNTER CABINET

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 1'-7" l x 2'-0" w. Provide stainless steel cabinet. Body to be 16 ga. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 4-16 COFFEE BREWER

Quantity: One (1)
Manufacturer: FETCO
Model: CBS-62H

1. One (1) Model CBS-62H 6000 Series Coffee Brewer, twin, 3 gallon capacity, automatic, on/off switch, gravity flow dispense tube system, gourmet coffee brew basket locks during brew cycle, hot water service, 2 gpm minimum flow rate, 20-75 psi, 3/8" male NPT, UL, cUL, NSF, (use with TPD-30 dispenser sold separately)
2. One (1) NOTE: Pricing and specifications subject to change with or without notice - Please call 1.800.FETCO.99 for confirmation
3. One (1) Circuit board: 3 year parts & 1 year labor warranty, standard

4. One (1) Electro-mechanical parts: 2 year parts & 1 year labor warranty, standard
5. One (1) All other parts: 1 year parts & 1 year labor warranty, standard
6. One (1) Model A039 Everpure® In-Line Water Filtration System, includes: filter head, connector hose, cartridge, & mounting hardware
7. One (1) Model C62016 3 x 3.0 kW heaters, 120/208-240v, 1-ph, 3+G wires, 6.9 - 9.1 kW, hardwired, 32.9 - 37.9 max amp draw, 18.0 - 21.0 gallons per hour
8. Three (3) Model D012 TPD-30 LUXUS® Thermal Dispenser, 3 gallon, stainless steel construction, twist & remove lid, thermally insulated, faucet & gauge guards, side handles
9. Three (3) 1 year parts warranty, standard

ITEM # 4-17 ADD ON FAUCET, FOR PRE-RINSE FAUCET

Quantity: One (1)
Manufacturer: T&S Brass
Model: B-0133-LB

1. One (1) Model B-0133-LB Pre-Rinse Unit, spring action, riser, hose and spray valve, less base faucet
2. One (1) Model B-0107-A Spray Valve Unit, with non-splash aerator
3. One (1) Model B-0310-LN Single Sink Faucet, wall mounted, 1/2" IPS flanged female inlet, four-arm handle, ("C" or "H")

ITEM # 4-18 WALL SHELF (KNIFE BRACKETS)

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 7'-6" l x 1"-0" w. Provide stainless steel wall shelf with knife brackets. Wall shelf shall be: 18 ga stainless steel with #4 finish, bracket shall be 14 ga stainless steel. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 4-19 WALL SHELF (KNIFE BRACKETS)

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 2'-0" l x 1"-0" w. Provide stainless steel wall shelf with knife brackets. Wall shelf shall be: 18 ga stainless steel with #4 finish, bracket shall be 14 ga stainless steel. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 4-20 SPARE NO.

ITEM # 4-21 DROP-IN ICE BIN

Quantity: One (1)
Manufacturer: Delfield
Model: 305

1. One (1) Model 305 Ice Bin/Chest, with cover, drop-in design, 21-1/4" W x 15-1/4" D x 13" H, 45-pound ice capacity, (17-3/4" x 12-1/2" cutout required), NSF
2. One (1) NOTE: Freight quotes are only valid from Delfield

ITEM # 4-22 ICE BIN FOR ICE MACHINES

Quantity: One (1)
Manufacturer: Scotsman
Model: B530S

1. One (1) Model B530S Ice Bin, top-hinged front-opening door, AHRI certified to 420 lb ice storage capacity, for top-mounted ice maker, polyethylene liner, metallic finish exterior, includes 6" legs, NSF
2. One (1) Seismic Legs
3. One (1) 3 year parts & labor warranties

ITEM # 4-23 ICE CUBER

Quantity: One (1)
Manufacturer: Scotsman
Model: C0830MA-32

1. One (1) Model C0830MA-32 Prodigy Plus® Ice Maker, cube style, air-cooled, self-contained condenser, production capacity up to 905 lb/24 hours at 70°/50° (724 lb AHRI certified at 90°/70°), stainless steel finish, medium cube size, 208-230v/60/1-ph, 10.2 amps, cULus, NSF, CE, ENERGY STAR®
2. One (1) 3 year parts & labor warranties
3. One (1) 5 year parts & labor warranties on Evaporator
4. One (1) 5 year parts on compressor & condenser
5. One (1) Model KVS Prodigy™ Vari-Smart™ Ice Level Control, program ice bin levels to match ice needs (field install only)

ITEM # 4-24 WATER FILTRATION SYSTEM

Quantity: One (1)
Manufacturer: Scotsman
Model: SSM2-P

1. One (1) Model SSM2-P Water Filter Assembly, twin system, designed for ice makers & beverage equipment, cubers over 650 lb, & up to 1200 lb, flakers & nuggets over 1200 lb, includes AquaArmor by AgION for antimicrobial protection, NSF, cULus

ITEM # 4-25 FLOOR TROUGH

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 2'-6" l x 1'-0" d. Provide stainless steel floor trough, and stainless-steel trough box with #4 finish. Provide IMC Teddy ASFT-ADA stainless steel accessible grating. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 4-26 WORK TABLE W/PREP SINK

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 7'-3" l x 2'-6" w. Provide stainless steel work table with 1-5/8" legs with adjustable flanged feet, lower and/or mid shelves, 6" high back and end splash. Top shall be 14 ga stainless steel, and legs shall be 16 ga. Fabricate and install per complete drawings, schedules, elevations, and details.
2. One (1) CSS Model PREP SINK Provide 16 ga stainless steel sink tub measuring approximately 18" w x 18" d x 12" h. Welded in place with polished seams.
3. One (1) Fisher Model 29033 DrainKing Waste Valve, flat strainer, overflow body, chrome finish

ITEM # 4-27 SPLASH MOUNTED PREP SINK FAUCET

Quantity: One (1)
Manufacturer: T&S Brass
Model: B-0231-CR

1. One (1) Model B-0231-CR Faucet, 12" swing nozzle, 8" wall mount base, 1/2" NPT female Inlets, ceramas cartridges

ITEM # 4-28 SPARE NO.

ITEM # 4-29 SPARE NO.

ITEM # 4-30 SPARE NO.

ITEM # 4-31 WALL SHELF (KNIFE BRACKETS)

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 7'-3" l x 1"-0" w. Provide stainless steel wall shelf with knife brackets. Wall shelf shall be: 18 ga stainless steel with #4 finish, bracket shall be 14 ga stainless steel. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 4-32 3 COMPARTMENT POT SINK

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 7'-6" l x 2'-6" w. Provide stainless steel pot sink assembly with 1-5/8" legs with adjustable flanged feet, lower and/or mid shelves, 8" high back and end splash. Top shall be 14 ga stainless steel, and legs shall be 16 ga. Fabricate and install per complete drawings, schedules, elevations, and details.
2. Three (3) CSS Model SINKS Provide 16 ga stainless steel sink tub measuring approximately 18" w x 26" d x 14" h. Welded in place with polished seams.
3. Three (3) Fisher Model 29033 DrainKing Waste Valve, flat strainer, overflow body, chrome finish

ITEM # 4-33 WALL SHELF (KNIFE BRACKETS)

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 1'-6" l x 1"-0" w. Provide stainless steel wall shelf with knife brackets. Wall shelf shall be: 18 ga stainless steel with #4 finish, bracket shall be 14 ga stainless steel. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 4-34 UTENSIL RACK

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 4'-8" l x 1/4" w x 2" d. Provide stainless steel flatbar utensil rack with sliding hooks 8" on center. Stainless steel shall be #4 finish. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 4-35 SPLASH MOUNTED HI-FLO UTENSIL SINK FAUCET

Quantity: Two (2)
Manufacturer: T&S Brass
Model: B-0291

1. Two (2) Model B-0291 Kettle & Pot Sink Faucet, Big-Flo, wall mounted 8" centers, 3/4" IPS model LL street EL inlets with locknuts, 18" swing nozzle, 175°F four arm handles, 1-1/4" diameter holes required in backsplash

ITEM # 4-36 WALL SHELF (KNIFE BRACKETS)

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 1'-6" l x 1"-0" w. Provide stainless steel wall shelf with knife brackets. Wall shelf shall be: 18 ga stainless steel with #4 finish, bracket shall be 14 ga stainless steel. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 4-37 MOBILE SHELVING UNITS

Quantity: One (1)
Manufacturer: Cambro
Model: CAMSHELVING

1. One (1) Model CAMSHELVING (LOT) 4 tier, 21" deep shelving units, posts to be 72" high, shelving units shall have a smooth surface without any welding or crevices. Posts and traverses shall be made of steel metal core with thick polypropylene covers. Shelf plates shall have a smooth surface without any welding or crevices, be of a structural web design and removable to be washed manually or in a commercial dishwasher. Shelf plates shall contain CamGuard, antimicrobial that inhibits the growth of mold, fungus and bacteria. Posts shall have dovetails that allow shelves to be adjusted in 4" increments. Provide with CSRDB donut bumper and CSCTL casters with brake. Verify sizes for shelves and posts by field measuring prior to ordering.

ITEM # 4-38 MOBILE WORK TABLE

Quantity: One (1)
Manufacturer: Custom
Model: STAINLESS STEEL

1. One (1) Model STAINLESS STEEL Approximately 8'-0" l x 5'-0" w. Provide stainless steel mobile work table with 1-5/8" legs, and lower and/or mid shelves. Top shall be 14 ga stainless

steel, and legs shall be 16 ga. Provide 5" dia. heavy-duty, non-marking casters, all with brakes. Fabricate and install per complete drawings, schedules, elevations, and details.

ITEM # 5-01 CABINET, ENCLOSED, BUN / FOOD PAN <NIC>

Quantity: Two (2)
Manufacturer: NIFSEC
Model: BY OTHERS

1. Two (2) Model BY OTHERS Cambro model PCUHC615, Pro Cart Ultra™ Hot/Cold Food Pan Carrier, electric, top heated only, bottom cold only, front loading, holds (16) 18" x 26" sheet pans, (32) 13" x 18" 1/2 size sheet pans, (32) GN 1/1 food pans, (16) 15-3/4" x 23-1/2" trays, (16) 16" x 16" x 2" pizza boxes, (2) gasket free magnetic quick-close doors, 4" nylon latches, menu pocket, 16 pairs adjustable stainless steel universal rails with 1-1/2" spacing, solar digital thermometer, molded-in handles, perimeter bumper, 9' cord with plug, (4) 6" x 2" heavy duty casters (2 fixed, 2 swivel with brakes), polyethylene exterior, charcoal gray, cETLus, NSF
2. Two (2) Cambro 110v/50/60/1-ph, 529 watts, 4.6 amps, NEMA 5-15P
3. Two (2) Cambro 110V/50/60/1-ph, 326.6 watts, 3.26 amps, NEMA 5-15P

ITEM # 5-02 MOBILE REFRIGERATED CABINET <NIC>

Quantity: One (1)
Manufacturer: NIFSEC
Model: BY OTHERS

1. One (1) Model BY OTHERS GA Systems model C37/TS12, Refrigerated Serving Cabinet, 37"W x 30-3/8"D x 34"H, bottom-mounted self-contained refrigeration (Refrigerated Snap In), (2) aluminum sliding lids with locking bar, holds (6) 4" deep or (12) 2" deep baskets, removable louvered front access panel, hot gas condensate evaporator, includes (2) locking pins, stainless steel construction, 3" swivel casters with brakes, R134a, ADA Compliant, UL, UL EPH CLASSIFIED
2. Floor Mtd. Convenience outlet w/ 90 degree angled plug set (NEMA 5-15P)
3. Color to be standard Spectrum Blue with Custom Graphics Option.
4. One (1) GA Systems Tray Shelf, drop-down design, 29"W x 12"D x 2"H, stainless steel construction, includes fold-down brackets

ITEM # 5-03 MOBILE REFRIGERATED CABINET <NIC>

Quantity: One (1)
Manufacturer: NIFSEC
Model: BY OTHERS

1. One (1) Model BY OTHERS GA Systems model C5, Refrigerated Serving Cabinet, 63-3/16"W x 30-3/8"D x 34"H, bottom-mounted self-contained refrigeration (Refrigerated Snap In), (2) aluminum sliding lids with locking bar, holds (6) 4" deep or (12) 2" deep baskets, removable louvered front access panel, hot gas condensate evaporator, includes (2) locking pins, stainless steel construction, 3" swivel casters with brakes, R134a, ADA Compliant, UL, UL EPH CLASSIFIED
2. Floor Mtd. Convenience outlet w/ 90 degree angled plug set (NEMA 5-15P)
3. Color to be standard Spectrum Blue with Custom Graphics Option.

ITEM # 5-04 MOBILE HEATED CABINET <NIC>

Quantity: One (1)
Manufacturer: NIFSEC
Model: BY OTHERS

1. One (1) Model BY OTHERS GA Systems model H5, Heated Serving Cabinet, 63-3/16"W x 30-3/8"D x 34"H, (2) sliding lids with locking bar, holds (12) 4" deep or (24) 2" deep baskets, stainless steel construction, includes: (2) locking pins, 3" plate casters with brakes, UL, UL EPH CLASSIFIED
2. Color is to be Standard "Spectrum Blue"
3. Wire Food Baskets (part of Small Wares) by School District.

ITEM # 5-05 MOBILE CASHIER STATION

Quantity: One (1)
Manufacturer: NIFSEC
Model: BY OTHERS

1. One (1) Model BY OTHERS GA Systems model, D3-MOD, Cash Stand Standard Cabinet, Size per plan x 30-3/8"W x 34"H. With locking cash drawer containing (4) coin/(4) bill insert. Manufacturer's standard features with removable laminate insert. Undershelf storage area can be used as a footrest, to be 19" clear from the front of the cabinet. 3" swivel non-marking wheels with brake
2. CSS Provide knock out and grommet for POS units and card readers electrical service.
3. Color is to be Standard "Spectrum Blue"

ITEM # 5-06 CASH REGISTER <NIC>

Quantity: One (1)
Manufacturer: NIFSEC

1. One (1) Cash Register - NIFSEC

ITEM # 5-07 HAND SINK

Quantity: One (1)
Manufacturer: IMC/Teddy
Model: ADA-WSX

1. One (1) Model ADA-WSX Handicap Hand Sink, wall mount, 14" wide x 16" front-to-back x 4" deep bowl, 10"H integrated backsplash, non-drip marine edge on front & sides, integral apron conceals plumbing, 16/304 stainless steel, ADA, NSF
2. One (1) Model ITD Integrated Towel Dispenser (built in to apron)
3. One (1) Model SD Soap Dispenser, stainless steel construction, 34oz capacity
4. Two (2) Model SS Side Splashes for hand sink (pair)

ITEM # 5-08 HAND SINK FAUCET, 4' CTR, DECK

Quantity: One (1)
Manufacturer: T&S Brass
Model: B-0325-CR

1. One (1) Model B-0325-CR Pantry Faucet, double, 4" c/c, swivel gooseneck, lever handles, 00AA inlets & Ceramas cartridges
2. One (1) Model B-0199-01F-15 Aerator, non-splash, flow control, 1.40 gpm, 55/64"-27 UNS female threads

ITEM # 5-09 DRY SHELVING UNITS

Quantity: Four (4)
Manufacturer: Cambro
Model: CAMSHELVING

1. Four (4) Model CAMSHELVING (LOT) 4 tier, 21" deep shelving units, posts to be 72" high, shelving units shall have a smooth surface without any welding or crevices. Posts and traverses shall be made of steel metal core with thick polypropylene covers. Shelf plates shall have a smooth surface without any welding or crevices, be of a structural web design and removable to be washed manually or in a commercial dishwasher. Shelf plates shall contain CamGuard, antimicrobial that inhibits the growth of mold, fungus and bacteria. Posts shall have dovetails that allow shelves to be adjusted in 4" increments. Provide dunnage stands for all traverses 54"

or longer and at corners where corner connectors are used. Provide in the configuration shown on plans, verify final sizes of shelves and posts by field measuring prior to ordering.

ITEM # 5-10 TRANSPORT UTILITY CART <NIC>

Quantity: One (1)
Manufacturer: NIFSEC
Model: BY OTHERS

1. One (1) Model BY OTHERS GA Systems model LC30, Lid Storage Cart, 26"W x 22"D x 30-1/2"H, (8) channels to hold Speedline lids while in service, 1-1/2" square tube construction, 5" plate type casters

ITEM # 5-11 PLUGGING BOX <NIC>

Quantity: Two (2)
Manufacturer: NIFSEC
Model: SEE ARCHITECTURAL SECTION

1. Two (2) Model SEE ARCHITECTURAL SECTION Plugging Box - NIFSEC, See Architectural Section

END OF SECTION 11 40 00 FOOD SERVICE EQUIPMENT SPECIFICATIONS

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SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes roller window shades.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.

B. Shop Drawings: Show location and extent of roller shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.

C. Samples for Initial Selection: For each colored component of each type of shade indicated.
   1. Include similar Samples of accessories involving color selection.

D. Samples for Verification:
   1. Complete, full-size operating unit not less than 16 inches wide for each type of roller shade indicated.
   2. For the following products:
      a. Shade Material: Not less than 3 inches square, with specified treatments applied. Mark face of material.
      b. Valance: Full-size unit, not less than 12 inches long.

E. Window Treatment Schedule: For roller shades. Use same designations indicated on Drawings.

F. Product Certificates: For each type of roller shade, signed by product manufacturer.

G. Qualification Data: For Installer.

H. Product Test Reports: For each type of roller shade.

I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of roller shade.

J. Maintenance Data: For roller shades to include in maintenance manuals. Include the following:
   1. Methods for maintaining roller shades and finishes.
   2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
   3. Operating hardware.

1.3 QUALITY ASSURANCE

A. Reference Standards:
1. 2016 California Building Standards Administrative Code, Part 1, Title 24 CBSC.
2. 2016 California Building Code (CBC), Part 2, Title 24 CBSC. (2015 International Building Code of the International Code Council, with California Amendments).
3. 2016 California Electrical Code (CEC), Part 3, Title 24 CBSC (2014 National Electrical Code, with California Amendments).
4. 2016 California Mechanical Code (CMC), Part 4, Title 24 CBSC (2015 Uniform Mechanical Code, with California Amendments).
5. 2016 California Plumbing Code (CPC), Part 5, Title 24, CBSC (2015 Uniform Plumbing Code, with California Amendments).
6. 2016 California Energy Code, Part 6, Title 24 CBSC.
7. 2016 California Historical Code, Part 8, Title 24 CBSC.
8. 2016 California Fire Code, Part 9, Title 24 CBSC. (2015 International Fire Code, with California Amendments).
9. 2016 California Green Building Standards Code (CALGreen Code), Part 11, Title 24 CBSC.
10. 2016 California Referenced Standards Code, Part 12, Title 24, CBSC.
11. NFPA 13 - Automatic Sprinkler Systems (California Amended), 2016 Edition.
12. NFPA 14 - Standpipe Systems (California Amended), 2013 Edition.
13. NFPA 17 - Dry Chemical Extinguishing Systems, 2013 Edition.
14. NFPA 17A - Wet Chemical Extinguishing Systems, 2013 Edition.
15. NFPA 20 - Stationary Pumps, 2016 Edition.
16. NFPA 24 - Private Fire Service Mains (California Amended), 2016 Edition.
17. NFPA 72 - National Fire Alarm and Signaling Code (California Amended).
18. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
19. NFPA 253 - Critical Radiant Flux of Floor Covering Systems, 2015 Edition.
20. NFPA 2001 - Clean Agent Fire Extinguishing Systems (California Amended), 2015 Edition.
21. Americans with Disabilities Act (ADA), Title II.

B. Installer Qualifications: Fabricator of products.

C. Source Limitations: Obtain roller shades through one source from a single manufacturer.

D. Fire-Test-Response Characteristics: Provide roller shade band materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and listing approved by CSFM.
1. Flame-Resistance Ratings: Passes NFPA 701.

E. Product Standard: Provide roller shades complying with WCMA A 100.1.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of roller shades that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: Lifetime.

B. Installer's Warranty: 2 years.

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. Rollers Shades: Before installation begins, for each size, color, texture, and pattern indicated, full-size units equal to 5 percent of amount installed, but not fewer than 2 units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Roller Shades: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
   1. MechoShade Systems, Inc. (Basis of Design)
   2. Draper Inc.
   3. Silent Gliss USA, Inc.
   4. Hunter Douglas.
   5. Or equal.

2.2 ROLLER SHADES

A. Type: Motorized and manual operated shades:

B. Mounting: As indicated on Drawings.

C. Solar Shade Cloth:

1. ThermoVeil 1300 Series basket weave shadecloths in 2 non-directional 2 x 2 basket-weave. Uniform scrim effect at the window wall with appropriate densities for sun control.
2. Content: 79% vinyl, 21% polyester core.
3. UV Test 200 sun-fade hours: None
4. 500 sun-fade hours: 5%.
5. Openness Factor: ±5%.
6. Color: As indicated on Drawings.

D. Product: AcoustiVeil Shadecloth Collection by MechoShade or equal.
1. Series: 0890 Series (0–1% open).
2. This series is composed of an eco-friendly material that unites form and function as a tightly woven, sound-absorbing, light-blocking, near-blackout textile.
3. Its woven flame-retardant polyester will enhance any interior.
4. With a Noise Reduction Coefficient (NRC) of 0.575, the shadecloth appreciably filters noise and reduces sound reverberation. When sound is absorbed, echoes are reduced.
5. Content: 100% polyester.

2.3 ACCESSORIES

A. Fascia:
1. Continuous removable extruded aluminum fascia that attaches to shade mounting brackets without the use of adhesives, magnetic strips, or exposed fasteners.
2. Fascia shall be able to be installed across two or more shade bands in one piece.
3. Fascia shall fully conceal brackets, shade roller and fabric on the tube.
4. Provide bracket / fascia end caps where mounting conditions expose outside of roller shade brackets.
5. Notching of Fascia for manual chain shall not be acceptable.

2.4 SHADE BAND

A. Shade Bands: Construction of shade band includes the fabric, the hem weight, hem-pocket, shade roller tube, and the attachment of the shade band to the roller tube. Sewn hems and open hem pockets are not acceptable.
1. Hem Pockets and Hem Weights: Fabric hem pocket with RF-welded seams (including welded ends) and concealed hem weights. Hem weights shall be of appropriate size and weight for shade band. Hem weight shall be continuous inside a sealed hem pocket. Hem pocket construction and hem weights shall be similar, for all shades within one room.
2. Shade Band and Shade Roller Attachment:
   a. Use extruded aluminum shade roller tube of a diameter and wall thickness required to support shade fabric without excessive deflection. Roller tubes less than 1.55 inch in diameter for manual shades, and less than 2.55 inches for motorize shades are not acceptable.
   b. Provide for positive mechanical engagement with drive / brake mechanism.
   c. Provide for positive mechanical attachment of shade band to roller tube; shade band shall be made removable / replaceable with a "snap-on" snap-off" spline mounting, without having to remove shade roller from shade brackets.

d. Mounting spline shall not require use of adhesives, adhesive tapes, staples, and/or rivets.
e. Any method of attaching shade band to roller tube that requires the use of: adhesive, adhesive tapes, staples, and/or rivets are not acceptable.

2.5 SHADE FABRICATION

A. Fabricate units to completely fill existing openings from head to sill and jamb-to-jamb, unless specifically indicated otherwise.

B. Fabricate shadecloth to hang flat without buckling or distortion. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling. Fabricate unguided shadecloth to roll true and straight without shifting sideways more than 1/8 inch in either direction per 8 feet of shade height due to warp distortion or weave design. Fabricate hem as follows:
1. Standard concealed hem bar.

2.6 COMPONENTS

A. Access and Material Requirements:
1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to be removed.
2. Provide shade hardware that allows for removal and re-mounting of the shade bands without having to remove the shade tube, drive or operating support brackets.
3. Use only Delrin engineered plastics by DuPont for all plastic components of shade hardware. Styrene based plastics, and /or polyester, or reinforced polyester will not be acceptable.

B. Manual Operated Chain Drive Hardware and Brackets:
1. Provide for universal, regular and offset drive capacity, allowing drive chain to fall at front, rear or non-offset for all shade drive end brackets. Universal offset shall be adjustable for future change.
2. Provide hardware capable for installation of a removable fascia, for both regular and/or reverse roll, which shall be installed without exposed fastening devices of any kind.
3. Provide shade hardware system that allows for removable regular and/or reverse roll fascias to be mounted continuously across two or more shade bands without requiring exposed fasteners of any kind.
4. Provide shade hardware system that allows for operation of multiple shade bands (multi-banded shades) by a single chain operator, subject to manufacturer's design criteria. Connectors shall be offset to assure alignment from the first to the last shade band.
5. Provide shade hardware system that allows multi-banded manually operated shades to be capable of smooth operation when the axis is offset a maximum of 6 degrees on each side of the plane perpendicular to the radial line of the curve, for a 12 degrees total offset.
6. Provide positive mechanical engagement of drive mechanism to shade roller tube. Friction fit connectors for drive mechanism connection to shade roller tube are not acceptable
7. Provide shade hardware constructed of minimum 1/8-inch thick plated steel or heavier as required to support 150 percent of the full weight of each shade.
8. Drive Bracket / Brake Assembly:

a. MechoShade Drive Bracket model shall be fully integrated with all MechoShade accessories, including, but not limited to: SnapLoc fascia, room darkening side / sill channels, center supports and connectors for multi-banded shades.
b. M5 drive sprocket and brake assembly shall rotate and be supported on a welded 3/8 inch steel pin.
c. The brake shall be an over-running clutch design which disengages to 90 percent during the raising and lowering of a shade. The brake shall withstand a pull force of 50 lbs. in the stopped position.
d. The braking mechanism shall be applied to an oil-impregnated hub on to which the brake system is mounted. The oil impregnated hub design includes an articulated brake assembly, which assures a smooth, non-jerky operation in raising and lowering the shades. The assembly shall be permanently lubricated. Products that require externally applied lubrication and or not permanently lubricated are not acceptable.
e. The entire M5 assembly shall be fully mounted on the steel support bracket, and fully independent of the shade tube assembly, which may be removed and reinstalled without effecting the roller shade limit adjustments.
f. Drive Chain: #10 qualified stainless steel chain rated to 90 lb. minimum breaking strength. Nickel plate chain shall not be accepted.

A. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Electric Motor: Manufacturer's standard tubular, enclosed in roller.
3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
   a. Individual Switch Control Station: Three-position, toggle-style, wall-switch-operated control station with open, close, and center off functions.
   b. Group Control Station: Three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.
   c. Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features; isolated from voltage spikes and surges.
4. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.
5. Operating Features:
   a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions, and located so shade band is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

3.3 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION 122413

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SECTION 125300 - RETAIL FURNITURE

PART 1 - GENERAL

1.1 SUMMARY

A. The work referred to in this section consists of furnishing all labor and material required to provide and deliver all retail fixtures as shown on Drawings and Schedules and specified herein into the building, uncrate, assemble, install, set in place, level, and completely install, exclusive of final utility connections. Final utility connections to all equipment shall be part of the work under additional appropriate sections of the work and not part of the retail furniture work.

1. The retail fixtures and its component parts shall be new, unused and free of defects.

2. The products or materials specified herein by trade names, manufacturer's name or catalog number shall be provided as specified. Substitutions will not be permitted unless approved by owner's representative in writing no later than 10 days prior to bidding. This stipulation applies to all products and materials. All substitutions or alternates will be expected to perform in all respects as well as the original specification. Should no request for substitution be received and approved as listed above, the project is to be provided as specified.

B. Field measurements shall be made prior to fabrications or installation of any equipment item.

C. Repair of all damage to the premises as a result of the fixture installation as well as the removal of all debris left by the work of this section.

D. Retail fixtures shall be cleaned and ready for operation at the time the facility is turned over to the Owner for final inspections by the Owner's Representative.

E. Retail Furniture Contractor shall be responsible for coordinating with the Architect and Contractor in submitting all applicable documents.

1.2 RELATED SECTIONS

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

B. All electric services including wiring to, and final connections to, the retail fixtures except, as specified differently in the specifications, drawings, or herein.

C. Floors, walls, ceilings, finishes and related building work, except as specified differently in the specifications, drawings, or herein.

1.3 SUBMITTALS

A. Regardless of drawing formats provided it will remain the responsibility of equipment supplier to develop submittals in accordance with the Specific Conditions and assume all required responsibilities there to. Checking product data, rough-in drawings and wall backing drawings by Designer is for design concept only, and does not relieve the Retail Furniture Contractor of responsibility for compliance with Contract Documents, verification of utilities with furniture requirements for conformity and location, verification of all dimensions of furniture and building conditions or reasonable adjustments due to deviations.

B. The Retail Furniture Contractor shall review and provide an affidavit with each submittal that such review has been completed by an authorized agent of the contractor.

C. Product Data: For each type of retail fixture indicated. Include manufacturer's model number and accessories.

D. Contract Document Drawings:

1. Drawings furnished, constitute as part of these specifications and show locations of furniture. Necessary deviation from the illustrated arrangements to meet structural conditions, shall be considered a part of the work of this section, such deviations shall be made without expense to the owner.

2. The drawings are for the assistance and guidance of the Retail Furniture Contractor. Exact locations shall be governed by the building configuration. The Retail Furniture Contractor shall accept his contract with this understanding.

1.4 QUALITY ASSURANCE:

A. Manufacturer Qualifications: Engage a firm experience in manufacturing retail fixtures similar to that indicated for this Project and with a record of successful in-service performance.

B. Installer Qualifications: Engage an experience installer to perform work of this Section who has specialized in installing retail fixtures, who has completed installation similar in design and extent to that indicated for this Project, and who has a record of successful in service performance.

C. Due to the user's preference and requirements for safety, performance and flexibility, all following specification line items are mandatory.

D. Product Options: Drawings indicate retail fixtures based on the specific projects indicated. Other manufacturers' fixtures with equal size and performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

E. Seismic Restraints: Provide seismic restraints for fixed retail fixtures as detailed in the Drawings and Schedules and specified herein.

F. Design Requirements: All shelving elevations as per attached drawing or described in the specifications.

G. Pre-installation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meeting." Review methods and procedures related to retail fixtures including, but not limited to, the following:

1. Review access requirements for retail fixture delivery.

2. Review retail fixture storage and security requirements.

3. Inspect and discuss condition of substrate and other preparatory work performed by other trades.

4. Review and finalize construction schedule and verify availability of material, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

H. Acceptable Manufacturers: Subject to compliance specifications, all retail fixtures shall be bid using products by manufacturers as identified on Drawings and Specifications as the basis of design. Retail Furniture Contractors to list their acceptable equal for the item specified. The owner will evaluate all bids based on overall quality, design and warranties.

I. Refer to Manufacturer Contact Information for additional information.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions of the retail fixture installation areas by field measurements before fixture fabrication and indicate measurements on Shop Drawings and Coordination Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Established Dimensions: Where filed measurements cannot be made without delaying the Work, establish required dimensions and proceed with fabricating equipment without field measurement. Coordinate construction to ensure actual dimensions correspond to established dimensions.

2. Retail aisles shall be a minimum of 36" wide.

B. Site Inspection: Inspect the site for conditions that will interfere with installation of retail fixtures as shown on drawings and on schedules.

C. Delivery, Storage & Handling: Comply with instructions and recommendations of manufacturer for special delivery, storage and handling requirements.

D. Environmental Limitations: Do not deliver or Install retail fixtures until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

E. Retail Fixtures shall be delivered and installed in accordance with construction schedule herein.

F. Retail Fixture vendor shall be responsible for coordination of order placement, shipping, delivery, and installation with construction schedule as prepared by Architect.

1.6 COORDINATION

A. Coordinate retail fixture layout and installation with other work, including light fixtures, HVAC equipment, and fire-suppression system components.

B. Coordinate any necessary access panels and cutouts for installation of electrical and data (electrical and data work, by others).

1.7 WARRANTY

A. General Warranty: Submit a written manufacturer's warranty, without monetary limitation, in which manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within 2 years from Substantial Completion.

PART 2 - PRODUCTS

2.1 METAL RETAIL FIXTURES

A. Provide Retail Fixtures as indicated on the fixture drawings and schedules, in the quantities shown.

B. Coordinate the location and installation of blocking as recommended by manufacturer, to be installed in walls by the project general contractor.

C. Provide items as manufactured by or equal:
OPTO International
1325 N. Mittel Blvd.
Wood Dale, IL 60191
847-541-6786

2.2 METAL RETAIL FIXTURES - MATERIALS

A. Refer to drawings for the material locations.

B. High-Pressure Laminate:
1. PL1: Wilsonart #7993-38 - Florance Walnut
2. PL2: Wilsonart #4877-38 - Grey Mesh
3. PL3: OPTO – Ice White
4. PL4: Wilsonart #D307-60 - Hollyberry

C. Quartz Countertops:
1. Q1: Cambria – Snowdon White

D. Powdercoat Finish:
1. M1: OPTO Powdercoat Finish – Champagne
2. M3: OPTO Powdercoat Finish – Skyline White

E. Acrylic:

1. FA1: OPTO – Frosted Acrylic

F. Melamine:

1. OPTO – Grey Melamine interiors for Casework

2.3 METAL RETAIL TEXTBOOK FIXTURES

A. Provide Retail Textbook Fixtures as indicated on the fixture drawings and schedules, in the quantities shown.

B. Coordinate the location and installation of blocking as recommended by manufacturer, to be installed in walls by the project general contractor.

C. Provide items as manufactured by or equal:
Lozier Corporation
P.O. Box 19999
Omaha, NE 68119-0999
800-228-9882

2.4 METAL RETAIL TEXTBOOK FIXTURES - MATERIALS

A. Refer to drawings for the material locations.

B. High-Pressure Laminate:
1. PL2: Wilsonart #4877-38 - Grey Mesh

C. Powdercoat Finish:
1. M2: Lozier Powdercoat Finish – Polychem PRMF2290PB (to match OPTO Champagne)

2.5 IPAD SURFACE MOUNT STAND

A. Provide and install Countertop iPad Kiosk as indicated on the fixture drawings and schedules, in the quantities shown.

B. Provide items as manufactured by or equal:
iPad Kiosks
440 Sagner Ave., Suite A
Frederick, MD 21701
301-732-4629
www.ipadkiosks.com

PART 3 - EXECUTION

3.1 EXAMINATION

A. Unless expressly stipulated, and in a timely manner, no additional allowances will be made for Contractors or Manufacturers for errors, omissions or ambiguities not reported at time of bidding. Carefully review and compare the Contract Documents and at once report to Owner and/or Designer any errors, ambiguities, inconsistencies or omissions. Unless expressly stipulated, and in a timely manner, Retail Furniture Contractor shall be liable to Owner or Designer for any damage resulting from such errors, inconsistencies or omissions in the Contract Documents. Work shall not be done without approved Drawings, Specifications and/or Modifications and without receiving prior written receiving authorizations from Owner or Designer. Drawings and retail fixture specifications are intended to complement each other. Therefore, neither should be considered complete without the others.

B. Examine areas and conditions, with Installer present, for compliance with requirements or installation tolerances, and other conditions affecting installation and performance of retail fixtures. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. Examine roughing-in for electrical and data to verify actual locations of connections before installation.

D. Verify all conditions at the building, particularly door openings and passageways for large retail fixtures. Coordinate with General Contractor access to insure delivery of the retail fixtures to the required areas. Coordination shall include, but not be limited to, early delivery, hoisting, window removal and/or delay of wall construction. All special equipment, handling charges, window removal, etc. shall be paid for by the Retail Furniture Contractor.

3.2 INSTALLATION

A. Install equipment with access and maintenance clearances according to manufacturer's written instructions and requirements of authorities having jurisdiction.

B. Install Retail Fixtures level, plumb, true, and straight to a tolerance of 1/8 inch in 96 inches. Shim as required with concealed shims.

C. Except for mobile and adjustable-leg equipment, securely anchor and attach items and accessories to walls or floors as the retail fixture drawings indicate.

D. Anchor wall shelving as the retail fixture drawings indicate. Secure with concealed fasteners of type and quantity required for complete installation.

E. All Low Voltage LED Shelf lighting to be installed by the retail fixture installation team. All lighting plugs directly into the wall.

F. Wiring of all service counter power and data is by project electrical contractor.

G. Blocking for all fixtures is by project general contractor.

H. Installation is to include freight and unloading of all items.

I. Installation is to include all related permits and fees.

J. Cleaning: Immediately upon completion of installation, clear components and surfaces. Remove surplus materials, rubbish and debris resulting from installation upon completion of work and leave areas of installation in neat, clean condition.

3.3 PROTECTING

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer that ensure retail fixtures are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 125300

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SECTION 13 31 23

TENSIONED FABRIC STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Section includes a tensioned fabric canopy system as shown on Drawings and specified in this Section.

2. Architect's drawings indicate design intent with respect to sizes, shapes, and configurations of the tensioned fabric canopy. Provide all components and accessories required for complete tensioned fabric canopy system, whether or not specifically shown or specified.

3. The tensioned fabric structure will assume bolted/pinned connections for field assembly. No field welding will be permitted.

B. The tensioned fabric structure Subcontractor shall be responsible for the structural design, detailing, fabrication, supply, and installation of the Work specified herein. The intent of this specification is to establish in the first instance an undivided, single-source responsibility of the Subcontractor for all of the foregoing functions.

C. Subcontractor's Work shall include the structural design, supply, fabrication, shipment, and erection of the following items:

1. The architectural membrane as indicated on the drawings and in these specifications.

2. Cables and fittings.

3. Perimeter, catenary, and sectionalized aluminum clamping system.

4. Coordination with steel frame manufacturer for proper cable fit up.

5. Fasteners and gasketing.

D. Related Requirements:

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

2. Division 03 Section "Cast-in-Place Concrete" for concrete footings for posts of tensioned fabric structure.

3. Division 05 Sections "Structural Steel Framing" and "Architecturally Exposed Structural Steel" for steel structure supporting tensioned fabric structure.

1.2 REFERENCES

A. Definitions:

1. Tensioned Fabric Structure: Cable and/or frame supported tensioned membrane-covered fabric structure; incorporating a fabric with low elongation characteristics under tension and capable of an anticlastic configuration. Fabric structures in which fabric is applied as flat or mono-axially curved configurations are not acceptable.

B. Reference Standards: Except as otherwise shown or noted, all work shall comply with the requirements of the following codes and standards:

1. American Institute of Steel Construction (AISC).

   a. AISC 303-05 Code of Standard Practice for Steel Buildings and Bridges
   b. ANSI/AISC 341-05 Seismic Provisions for Structural Steel Buildings

2. American Society of Civil Engineers.

   a. ASCE 19: Structural Applications of Steel Cables for Buildings.

3. American Society of Testing and Materials (ASTM).

   a. ASTM A586: Standard Specifications for Zinc-Coated Steel Structural Strand.
   b. ASTM A603: Standard Specifications for Zinc-Coated Steel Structural Wire Rope.
   c. ASTM D4851-88: Standard Test Methods for Coated and Laminated Fabrics for Architectural Use.
   d. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials.
   e. ASTM E108: Standard Test Methods for Fire Test and Roof Coverings.
   f. ASTM E136: Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.
   g. ASTM C423: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
   h. ASTM E424: Standard Test Method for Solar Energy Transmittance and Reflectance of Sheet Materials.

4. American Welding Society (AWS).

   a. AWS D1.1: Structural Welding Code.
   b. AWS 2.4: Symbols for Welding and Nondestructive Testing.

5. Aluminum Association

   a. Specifications for Aluminum Structures.

6. National Fire Protection Association (NFPA).

   a. NFPA 701: Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

7. Steel Structures Painting Council (SSPC).

a. Steel Structures Painting Manual, Volumes 1 and 2.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include styles, material descriptions, construction details, fabrication details, dimensions of individual components and profiles, hardware, fittings, mounting accessories, features, and finishes for tensioned fabric structures.

2. Include rated capacities, light transmissions, and operating characteristics of furnished specialties and accessories.

B. Samples for Verification: For the following:

1. Fabric: Qty (3) 8 ½" x 5 1/2" samples of fabric as selected by the architect.

C. Provide a Schedule of Values within (2) weeks of project award.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, fabricator and professional engineer.

B. Welding certificates.

C. Sample Warranty: For fabric warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For tensioned fabric structures to include in operation and maintenance manuals.

1. Include the following:

a. Methods for maintaining tensioned fabric structure fabrics and finishes.
b. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate tensioned fabric structures similar to those required for this Project and whose products have a record of successful in-service performance.

1. Fabricator is a Master Fabric Craftsman certified by the Industrial Fabrics Association International.

2. Fabricator's responsibilities include fabricating and installing tensioned fabric structures and providing professional engineering services needed to assume engineering responsibility.

3. Fabricator's engineering services must utilize Finite Element Analysis software that performs fabric form finding and takes into account fabric material properties and prestress characteristics.
4. Fabricator must have proven record of at least (5) successful projects of similar size and similar specified fabric material.
5. Fabricator must have been in continuous operation as a professional tensioned fabric structure manufacturer for minimum of (10) years prior to contract.
6. Fabricator must have an in-house Made-in-America manufacturing facility for both frame and fabric membrane components.
7. Fabricator must manufacture and operate in the state of California.

B. Installer Qualifications: Fabricator of products.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit installation of tensioned fabric structure in exterior locations to be performed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Where tensioned fabric structure installation is indicated to fit to other work, verify dimensions of other work by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for fenestration operation throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 WARRANTY

A. Special Warranty: Manufacturer and fabricator agree to repair or replace components of tensioned fabric structures that fail in materials or workmanship within specified warranty period of one year from the date of Substantial Completion.

1. Failures include, but are not limited to, the following:
   a. Deterioration of fabric including seam failure.
   b. Deterioration of cables and fittings.
2. Fabric: 10 year Warranty Period against UV degradation. Reference the manufacturer's limited warranty for the specified fabric manufacturer and product.
3. Warranty Period, Cables, Securement Devices and Accessories: One year from date of Substantial Completion

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design: Subject to compliance with requirements, provide the tensioned fabric structures designed, engineered, fabricated and installed by the following:

1. Eide Industries, Inc.

   a. Address: 16215 Piuma Avenue, Cerritos, California USA 90703.
   b. Contact: Erik Jarvie, Sales Engineer. Phone: (562) 402-8335 x125; Email: erik@eideindustries.com

2. Or approved equal. Manufacturer must meet all minimum requirements as outlined in item 1.6 QUALITY ASSURANCE of this section and show written proof for each item listed to become an approved equal.

3. Substitution requests must be submitted to architects, owners and the DSA for review and approval, which will require additional resubmittal fees.

B. Source Limitations: Obtain tensioned fabric structures from single source from single manufacturer.

2.2 DESCRIPTION

A. General: Provide a tensioned fabric structure system that complies with requirements specified herein by testing the Subcontractor's corresponding membrane system in accordance with the indicated test methods.

B. Regulatory Requirements: Provide tensioned fabric canopy system complying with requirements and limitations of authorities having jurisdiction that are within Contractor's control.

1. Building Code Criteria: The tensioned fabric structure shall comply with the California Building Code, 2016 edition.

2. Comply with California building code and respective loading criteria for Snow Loads, Live Loads, Dead Loads, Wind Speed, and Seismic Loads.

3. Life Safety: Tensioned fabric structure shall be detailed so that no life safety issue is created in the event of a loss of a part of the membrane. The tensioned fabric structure shall not rely on the membrane for structural stability.

2.3 PERFORMANCE / DESIGN CRITERIA

A. In engineering tensioned fabric canopy system fittings and accessories to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

1. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.

2. Copper Alloys: 60 percent of minimum yield strength.

3. Stainless Steel: 60 percent of minimum yield strength.

4. Steel: 72 percent of minimum yield strength.

B. Structural Performance: Tensioned fabric canopy system shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7 as modified by CBC 2016:

1. Load parameters: Refer to approved DSA drawing's for basic wind and seismic parameters.

C. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

1. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.

2. Copper Alloys: 60 percent of minimum yield strength.

3. Stainless Steel: 60 percent of minimum yield strength.

4. Steel: 72 percent of minimum yield strength.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

E. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

2.4 CANOPY FABRIC MATERIALS

A. Product: Subject to compliance with requirements, provide fabric as called out and specified by the Architect in the bid drawings.

B. Fire-Test-Response Characteristics: Provide canopy fabric with the fire-test-response characteristics indicated, as determined by testing identical products according to test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Flame-Resistance Ratings: Passes NFPA 701 & CSFM Title 19

2. Flame Spread: ASTM E84, Class

3. Incombustibility of substrate: Pass ASTM E108 and ASTM E136

C. PTFE Fabric manufacturer: The following is a list of approved PTFE fabric manufacturers for tensioned fabric structures.

1. Saint Gobain Performance Plastic Sheerfill V

2. Chukoh

D. Fabric properties:

1. Fabric thickness and tensile strength: Must meet engineering requirements with a safety factor of five.
2. Color: White (after several weeks of UV exposure)
3. Waterproof.

2.5 CANOPY FRAME, CABLES, FITTINGS AND ACCESSORIES

A. General: Provide accessories as standard with tensioned fabric canopy system fabricator and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

B. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

C. Frame material shall be shall be constructed of cold rolled carbon steel unless otherwise specified by the architect in the bid drawings.

D. Steel and Iron:
1. Tubing: ASTM A 500 Grade B (yield 42 ksi)
2. Bars: Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
3. Plates, Shapes, and Bars: ASTM A 36 or ASTM A 572 per engineering requirements.

E. Aluminum:
1. Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
2. Extruded Bars and Shapes: ASTM B 221, Alloy 6063-T5/T52.

2.6 CANOPY FRAME FINISH

A. Frame Finish shall be polyester powder painted unless otherwise specified by the architect in the bid drawings.
1. Powder Coat Finish:
   a. Commercial blast clean surface in accordance to SSPC-SP 10.
   b. Apply polyester powder coat paint to a minimum of 3 mils thick.
   c. Color: Crème RAL 9001.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine structural steel framing and other substrates, 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.

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

3.2 ERECTION

A. Proceed with installation of tensioned fabric structure only when existing and forecasted weather conditions will permit work to be performed in accordance with manufacturer's recommendations.

B. Erect frame and fabric in accordance with the procedures of the approved manufacturer.

C. Adequate prestress shall be applied to eliminate fabric wrinkles and excess cable sag.

3.3 FIELD QUALITY CONTROL

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

B. Prepare test and inspection reports.

3.4 MEMBRANE PATCHING

A. Any and all patching must be done by trained and authorized personnel.

B. Minor repairs are defined as:
   1. A patch, no larger than 1% of the area of the fabric panel.
   2. Sewn or sealed reinforcement at corners or joints, sewing and sealing no greater than 12 inches in length.

C. A maximum of one patch per membrane will be permissible.

D. No more than two patches will be allowed for the entire project.

E. Sewn or sealed reinforcement is allowed at all corners when necessary.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to one visit to Project during other-than-normal occupancy hours for this purpose.

3.6 CLOSEOUT ACTIVITIES

A. Demonstration: Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust cable and fabric tension and to clean and maintain canopy fabric.

END OF SECTION 13 31 23

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SANTA ANA COLLEGE
JOHNSON STUDENT CENTER (INCREMENT 2)

SECTION 142100 – ELECTRIC TRACTION ELEVATORS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies electric traction elevators.

B. Work Required:

1. The work required under this section consists of all labor, materials and services required for the complete installation (including operational verification) of all the equipment required for the elevator(s) as herein specified.

2. All work shall be performed in a first class, safe and workmanlike manner.

3. In all cases where a device or part of the equipment is herein referred to in the singular, it is intended that such reference shall apply to as many of such devices or parts as are required to make complete installation.
4. District requires that exterior elevator shall be provided with lockout capability.

C. Applicable Codes: Comply with applicable building and elevator codes at the project site, including but not limited to the following:

1. ANSI A117.1, Buildings and Facilities, Providing Accessibility and Usability for Physically Handicapped People.
2. ADAAG, Americans with Disabilities Act Accessibility Guidelines.
3. ANSI/NFPA 70, National Electrical Code.
4. ANSI/NFPA 80, Fire Doors and Windows.
5. ASME/ANSI A17.7, Safety Code for Elevators and Escalators.
6. ANSI/UL 10B, Fire Tests of Door Assemblies.
7. CAN/CSA C22.1, Canadian Electrical Code.
8. CAN/CSA-B44, Safety Code for Elevators and Escalators.
9. EN 12016 (May 1998): "EMC Product Family Standards for lifts, escalators, and passenger conveyors Part 2 – immunity"
10. Local Building Codes
11. All other local applicable codes.

1.02 SYSTEM DESCRIPTION

A. Equipment Description: Gen2® gearless machine-room less elevator

B. Equipment Control: Elevonic® Control System.

C. Drive: Regenerative

D. Quantity of Elevators: Two (2)

E. Elevator Stop Designations: 1, 2

F. Stops : Two (2)

G. Openings: Two (2) in line

H. Travel (maximum): 18'-0"

I. Rated Capacity: 3,500 lb. (Elev 1), 4,000 lb. (Elev 2)

J. Rated Speed: 200 fpm

K. Platform Size: 6'-6 ¾" W x 6'-1 1/8" D (Elev 1), 7'-7 ¼" W x 6'-1 1/8" D (Elev 2)

L. Clear Inside Dimensions: 6'-5 9/16" W x 5'-5 9/16" D (Elev 1), 7'-5 9/16" W x 5'-5 9/16" D (Elev 2)

M. Cab Height: 7'9"

N. Clear Cab Height: 7'-9" with 5/16" floor recess and 4 LED ceiling

O. Entrance Type and Width: Single-Slide 42" Wide (Elev1), Center-Opening, 48" Wide (Elev 2)

P. Entrance Height: 7'-0"

Q. Main Power Supply: 480 Volts + or - 5% of normal, three-Phase, with a separate equipment grounding conductor.

R. Car Lighting Power Supply: 120 Volts, Single-phase, 15 Amp, 60 Hz.

S. Machine Location: Inside the hoistway at the top.

T. Signal Fixtures: Manufacturer's standard with metal button targets

U. Controller Location: Adjacent at Lowest Landing

V. Performance:

1. Car Speed: $\pm$ 3 % of contract speed under any loading condition or direction of travel.
2. Car Capacity: Safely lower, stop and hold up to 120% of rated load. (code required).
3. Ride Quality:
   a. Vertical Vibration (maximum): 20 milli-g
   b. Horizontal Vibration (maximum): 12 milli-g
   c. Vertical Jerk (maximum): 4.59 ± 1.0 ft./ sec^3 (1.4 ± 0.3 m/ sec^3)
   d. Acceleration/Deceleration (maximum): 2.62 ft./ sec^2 (0.8 m/ sec^2)
   e. In Car Noise: 55 – 60 dB(A)
   f. Stopping Accuracy: $\pm$ 0.375 in. ($\pm$ 10 mm) max, $\pm$ 0.25 in. ($\pm$ 6 mm) Typical
   g. Re-leveling Distance: $\pm$ 0.5 in. ($\pm$ 12 mm)

W. Operation:
Simplex Collective Operation: Using a microprocessor-based controller, operation shall be automatic by means of the car and hall buttons. If all calls in the system have been answered, the car shall park at the last landing served.

X. Operating Features – Standard
1. Full Collective Operation
2. Anti-nuisance.
3. Fan and Light Protection.
4. Load Weighing Bypass.
5. Independent Service.
6. Full Collective Operation.
7. Firefighters' Service Phase I and Phase II
8. Top of Car Inspection.

Y. Door Control Features:
1. Door control to open doors automatically when car arrives at a landing in response to a normal hall or car call.
2. Elevator doors shall be provided with a reopening device that will stop and reopen the car door(s) and hoistway door(s) automatically should the door(s) become obstructed by an object or person.
Door protection shall consist of a two dimensional, multi-beam array projecting across the car door opening.
3. Door nudging operation to occur if doors are prevented from closing for an adjustable period of time.

Z. Provide equipment according to seismic zone: 4 in accordance with Seismic Design Criteria

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's product data for each system proposed for use. Include the following:
1. Signal and operating fixtures, operating panels and indicators.
2. Cab design, dimensions and layout.
3. Hoistway-door and frame details.
4. Electrical characteristics and connection requirements.
5. Expected heat dissipation of elevator equipment in hoistway (BTU).
6. Color selection chart for Cab and Entrances.

B. Shop Drawings: Submit approval layout drawings. Include the following:
1. Car, guide rails, buffers and other components in hoistway.
2. Maximum rail bracket spacing.
3. Maximum loads imposed on guide rails requiring load transfer to building structure.
4. Clearances and travel of car.
5. Clear inside hoistway and pit dimensions.
6. Location and sizes of access doors, hoistway entrances and frames.

C. Operations and Maintenance Manuals: Provide manufacturer's standard operations and maintenance manual.

1.04 QUALITY ASSURANCE

A. Manufacturer: Minimum of fifteen years experience in the fabrication, installation and service of elevators of the type and performance of the specified. The manufacturer shall have a documented quality assurance program.

B. Installer: Elevators shall be installed by the manufacturer.

C. Permits, Inspections and Certificates: The Elevator Contractor shall obtain and pay for necessary Municipal or State Inspection and permit as required by the elevator inspection authority, and make such tests as are called for by the regulations or such authorities. These tests shall be made in the presence of such authorities or their authorized representatives.

1.05 DELIVERY, STORAGE AND HANDLING

A. Should the building or the site not be prepared to receive the elevator equipment at the agreed upon date, the General Contractor will be responsible to provide a proper and suitable storage area

on or off the premises.

Should the storage area be off-site and the equipment not yet delivered, then the elevator contractor, upon notification from the General Contractor, will divert the elevator equipment to the storage area. If the equipment has already been delivered to the site, then the General Contractor shall transport the elevator equipment to the storage area. The cost of elevator equipment taken to storage by either party, storage, and redeliver to the job site shall not be at the expense of the elevator contractor.

1.06 WARRANTY

A. The elevator contractor's acceptance is conditional on the understanding that their warranty covers defective material and workmanship. The warranty period shall not extend longer than one (1) year from the date of completion or acceptance thereof by beneficial use, whichever is earlier, of each elevator. The warranty excludes: ordinary wear and tear, improper use, vandalism, abuse, misuse, or neglect or any other causes beyond the control of the elevator contractor and this express warranty is in lieu of all other warranties, express or implied, including any warranty of merchantability or fitness for a particular purpose.

B. Installer's warranty: 2 years.

1.07 MAINTENANCE and SERVICE

A. Maintenance service consisting of regular examinations and adjustments of the elevator equipment shall be provided by the elevator contractor for a period of twelve (12) months after the elevator has been turned over for the customer's use. This service shall not be subcontracted but shall be performed by the elevator contractor. All work shall be performed by competent employees during regular working hours of regular working days. This service shall not cover adjustments, repairs or replacement of parts due to negligence, misuse, abuse or accidents caused by persons other than the elevator contractor. Only genuine parts and supplies as used in the manufacture and installation of the original equipment shall be provided.

B. The periodic lubrication of elevator components shall **not** be required, including: Sheaves, Rails, Belts, Ropes, Car and CWT guides, etc

C. The elevator control system must:

1) Provide in the controller the necessary devices to run the elevator on inspection operation.
2) Provide on top of the car the necessary devices to run the elevator in inspection operation.
3) Provide in the controller an emergency stop switch. This emergency stop switch when opened disconnects power from the brake and prevents the motor from running.
4) Provide in the event of a power outage, means from the controller to electrically lift and control the elevator brake to safely bring the elevator to the nearest available landing.
5) Provide the means from the controller to reset the governor over speed switch and also trip the governor.
6) Provide the means from the controller to reset the emergency brake when set because of an unintended car movement or ascending car over speed.
7) Provide the means from the controller to reset elevator earthquake operation.

D. Provide system capabilities to enable a remote expert to create a live, interactive connection with the elevator system to enable the following functions:

1. Remotely diagnose elevator issues with a remote team of experts

2. Remotely return an elevator to service
3. Provide real-time status updates via email
4. Remotely make changes to selected elevator functions including:
    a. Control building traffic: Restrict floor access, remove car from group operation, shut down elevator, select up peak/down peak mode, activate independent service
    b. Conserve energy: Activate cab light energy save mode, activate fan energy save mode, shut down car(s)
    c. Improve passenger experience: Extend door open times, change parking floor, activate auto car full, activate anti-nuisance, advance door opening, door nudging, extend specific floor extended opening time, release trapped passengers

PART 2 - PRODUCTS

2.01 DESIGN AND SPECIFICATIONS

A. Provide machine-roomless Gen2™ traction passenger elevators from Otis Elevator Company, Mitsubishi, KONE or approved equal. The control system and car design based on materials and systems manufactured by Otis Elevator Company. Specifically, the system shall consist of the following components:

1. An AC gearless machine using embedded permanent magnets mounted at the top of the hoistway.
2. Polyurethane Coated-Steel Belts for elevator hoisting purposes.
3. Regenerative drive that captures normally wasted energy and feeds clean power back into the building's power grid.
4. LED lighting standard in ceiling lights and elevator fixtures.
5. Sleep mode operation for LED ceiling lights and car fan.

B. Approved Installer: Otis Elevator Company

2.02 SPECIAL "APPROVED EQUAL DSA APPROVAL PROCESS AND REQUIREMENTS

A. Basis of Design product has been approved by DSA. If Contractor elects to provide one of the approved equal products listed above, it is solely responsible for obtaining all necessary approvals and all costs associated with obtaining the approval of DSA, including all Architectural and Engineering fees for coordinating with DSA related to the approved equal product proposed by the Contractor, are the sole responsibility of the Contractor. Do not commence installation until all approvals have been obtained. The District is not responsible for any costs or delays (including any costs related to delays, schedule impacts, etc.), including any delays or costs caused by or related to DSA or any other governmental agency having jurisdiction over the project, arising from, or related in any manner to, the Contractor electing to provide one of the approved equal products listed above.

B. Submit require submittal to Architect within 35 calendar days from the date of issuance of Notice to Proceed, and before any materials are delivered to the job site. Contractor is solely responsible for obtaining all necessary approvals. Do not commence installation of any approval item until all DSA approvals have been obtained.

C. Product Data: Submit manufacturer's specifications and certified test reports made by an independent testing organization for each type and class of material to show compliance with code requirements and obtain approval of DSA.

D. Shop Drawings: Submit complete shop drawings including dimensioned plans, elevations, and all details of typical sections and connections. Shop drawings shall show design loads and all details of the installation. Title sheet of shop drawings shall list testing requirements and shall state that a licensed engineer shall review and certify the completed installation is in accordance with the approved shop drawings. Shop drawings shall be stamped, dated and signed by a professional engineer licensed in the State of California as evidence of his or her responsibility for the work.

E. Shop drawings:

F. Format: 30" x 42" sheet format with border and title block identifying, at a minimum, the project name, project number, project location, date, contractor and structural engineer of record.

G. 1 set of reproducible shop drawings each submittal review.

H. 1 set of reproducible shop drawings for each plan check review.

I. 1 set of reproducible shop drawings approved by DSA.

J. Calculations: Submit calculations prepared by a professional engineer licensed in the State of California. Engineer shall sign, date and stamp calculations as evidence of his or her responsibility for the work.

K. Submittals shall be approved first by the Architect, then by the DSA.

2.02 EQUIPMENT: CONTROLLER COMPONENTS

A. Controller: A microcomputer based control system shall be provided to perform all of the functions of safe elevator operation. The system shall also perform car and group operational control.

1. All high voltage (110V or above) contact points inside the controller shall be protected from accidental contact when the controller doors are open.
2. Controller shall be separated into two distinct halves; Motor Drive side and Control side. High voltage motor power conductors shall be routed so as to be physically segregated from the rest of the controller.
3. Field conductor terminations points shall be segregated; high voltage (>30 volts DC and 110 VAC,) and low voltage (< 30 volts DC)
4. Controllers shall be designed and tested for Electromagnetic Interference (EMI) immunity according to the EN 12016 (May 1998): "EMC Product Family Standards for lifts, escalators, and passenger conveyors Part 2 – immunity"
5. Controller shall be located inside the wall next to the top landing entrance frame. Emergency access shall be provided through an access panel in the entrance frame secured by a key lock.
6. A separate control room or cabinet should not be required.

B. Drive: A Variable Voltage Variable Frequency AC drive system shall be provided. The drive shall be set up for regeneration of AC power back to the building grid.

C. Back-up power source: Provide with standby power source.

2.03 EQUIPMENT: MACHINE AND GOVERNOR

A. Machine: AC gearless machine, with a synchronous permanent-magnet motor, dual solenoid service and emergency disc brakes, mounted at the top of the hoistway.

B. Governor: The governor shall be a tension type car-mounted governor.

C. Buffers, Car and Counterweight: Polyurethane type buffers shall be used.

D. Hoistway Operating Devices:
1. Emergency stop switch in the pit
2. Terminal stopping switches.

E. Positioning System: Consists of an encoder, reader box, and door zone vanes.

F. Guide Rails and Attachments: Guide rails shall be Tee-section steel rails with brackets and fasteners. Side counterweight arrangements shall have a dual-purpose bracket that combines both counterweight guide rails, and one of the car guide rails to building fastening.

G. Coated-Steel Belts: Polyurethane coated belts with high-tensile-grade, zinc-plated steel cords and a flat profile on the running surface and the backside of the belt. All driving sheaves and deflector sheaves should have a crowned profile to ensure center tracking of the belts. A continuous 24/7 monitoring system using resistance based technology has to be installed to continuously monitor the integrity of the coated steel belts and provide advanced notice of belt wear.

H. Governor Rope: Governor rope shall be steel and shall consist of at least eight strands wound about a sisal core center.

I. Fascia: Galvanized sheet steel shall be provided at the front of the hoistway.

J. Hoistway Entrances:

1. Frames: Entrance frames shall be of bolted construction for complete one-piece unit assembly. All frames shall be securely fastened to fixing angles mounted in the hoistway and shall be of UL fire rated steel.

2. Sills shall be extruded aluminum.

3. Doors: Entrance doors shall be of metal construction with vertical channel reinforcements.

4. Fire Rating: Entrance and doors shall be UL fire rated for 1-1/2 hour

5. Entrance Finish: #4 Satin Stainless Steel

6. Entrance marking plates: Entrance jambs shall be marked with 4" x 4" plates having raised floor markings with Braille located adjacent to the floor marking. Marking plates shall be provided on both sides of the entrance.

7. Sight Guards: sight guards will be furnished with all doors painted to match with painted doors, painted black for stainless steel and gold satin doors.

2.04 EQUIPMENT: CAR COMPONENTS

A. Car frame and Safety: A car frame fabricated from formed or structural steel members shall be provided with adequate bracing to support the platform and car enclosures. The car safety shall be integral to the car frame and shall be Type "B", flexible guide clamp type.

B. Cab: Otis' Premium Cab: Steel sell cab with raised laminate hang on panels. Laminate color to be selected from manufacturer's catalog of choices.

C. Car Front Finish: #4 Satin Stainless Steel

D. Car Door Finish: #4 Satin Stainless Steel

E. Ceiling Type: Flat steel ceiling with a Real White paint finish and 4 LED lights.

F. Emergency Car Lighting: An emergency power unit employing a 6-volt sealed rechargeable battery and totally static circuits shall be provided to illuminate the elevator car in the event of building power failure.

G. Fan: A one-speed 120 VAC fan will be mounted to the ceiling to facilitate in-car air circulation, meeting A17.1 code requirements. The fan shall be rubber mounted to prevent the transmission of structural vibration and will include a baffle to diffuse audible noise. A switch shall be provided in the car-operating panel to control the fan.

H. Handrail: Handrail shall be provided on the rear wall of the car enclosure. Handrail shall be 1 ½" diameter round bar handrail with a #4 Satin Stainless Steel Finish.

I. Threshold: Extruded Aluminum

J. Emergency Exit Contact: An electrical contact shall be provided on the car-top exit.

K. Guides: The car shall have 3" diameter roller guides at top and bottom and the counterweight shall have slide type guides at the top and the bottom.

L. Platform: The car platform shall be constructed of metal. Load weighing device shall be mounted on the belts at the top of the hoistway.

M. Certificate frame: Provide a Certificate frame with a satin stainless steel finish.

N. The LED ceiling lights and the fan should automatically shut off when the system is not in use and be powered back up after a passenger calls the elevator and pushes a hall button.

2.05 EQUIPMENT: SIGNAL DEVICES AND FIXTURES

A. Car Operating Panel: One (1) car operating panel shall be provided which contains all push buttons, key switches, and message indicators for elevator operation. The car operating panel shall have a #4 satin stainless steel finish.

Car operating panel shall contain a bank of round stainless steel, mechanical LED illuminated buttons. Flush mounted to the panel and marked to correspond to the landings served. All buttons to have raised numerals and Braille markings with 1/8" satin stainless steel projecting button with blue illuminating halo.

The car operating panel shall be equipped with the following features:

1. Raised markings and Braille to the left hand side of each push-button.
2. Car Position Indicator at the top of and integral to the car operating panel.
3. Door open and door close buttons.
4. Inspection key-switch.
5. Elevator Data Plate marked with elevator capacity and car number.

6. Help Button: The help button shall initiate two-way communication between the car and a location inside the building, switching over to another location if the call is unanswered, where personnel are available who can take the appropriate action. Visual indicators are provided for call initiation and call acknowledgement.
7. Landing Passing Signal: A chime bell shall sound in the car to signal that the car is either stopping at or passing a floor served by the elevator.
8. In car stop switch (toggle or key unless local code prohibits use)
9. Firefighter's hat (standard USA)
10. Firefighter's Phase II Key-switch (standard USA)
11. Call Cancel Button (standard USA)
12. Firefighter's Phase II Emergency In-Car Operating Instructions: worded according to A17.1 2000, Article 2.27.7.2.

B. Car Position Indicator: A digital, LED car position indicator shall be integral to the car operating panel.

C. Hall Fixtures: Hall fixtures shall be provided with necessary push buttons and key switches for elevator operation. Hall fixtures shall have a 1/8" satin stainless steel projecting button with blue halo.

D. Car Lantern and Chime: A directional lantern visible from the corridor shall be provided in the car entrance. When the car stops and the doors are opening, the lantern shall indicate the direction in which the car is to travel and a chime will sound.

E. Access key-switch at top floor in entrance jamb.

F. Access key-switch at lowest floor in entrance jamb.

PART 3 - EXECUTION

3.01 PREPARATION

A. Take field dimensions and examine conditions of substrates, supports, and other conditions under which this work is to be performed. Do not proceed with work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Installation of all elevator components except as specifically provided for elsewhere by others.

3.03 DEMONSTRATION

A. The elevator contractor shall make a final check of each elevator operation with the Owner or Owner's representative present prior to turning each elevator over for use. The elevator contractor shall determine that control systems and operating devices are functioning properly.

END OF SECTION

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SECTION 211313

WET-PIPE SPRINKLER SYSTEM

PART 1 – GENERAL

1.1 GENERAL DESCRIPTION

A. Furnish all materials and labor for the detailed design and installation for a new fire sprinkler (wet-pipe) system, hereafter referred to as the "System" in compliance with this Specification.

B. The contract drawings and this Specification define the scope of work for the project. The contract drawings are intended to be engineered working plans only in accordance with NFPA 13 Chapter 23 and the DSA AFSS Guidelines and the Contractor's responsibilities are defined herein. Where conflicts occur between the Specification and the contract drawings, the bidder is instructed to request clarification prior to bidding. In general, should a conflict occur, it is the Contractor's responsibility to request verification prior to bidding.

C. The work shall be subject to the terms and conditions contained in the Construction Contract agreement between the Contractor and the Architect/Owner/District.
   1. All applicable fees, taxes, and permit costs for all work contained in this specification section shall be included in the Contractor's base bid.

D. Contractor shall be responsible for the review and compliance with this Specification section and the DSA approved plans and calculations. All work shall be performed in accordance with these Specifications and good engineering and installation practice. Modifications to these Specifications will NOT be accepted without the expressed written approval of Architect/Owner, Architect/Owner's Representative and/or Architect/Owner's insurance carrier; herein referred to as the "Architect/Owner". It is the Contractor's responsibility to document the required approvals of any such modifications prior to the execution of work. It is the Contractor's responsibility to document the intent to modify the approved design and document all required approvals of any such modifications deemed "major changes" based on DSA Policy PL 10-01, Section 4.3.1 prior to bid and prior to the execution of work. Change of the design by the contractor as outlined in Section 4.3.1 will NOT be accepted without the express written approval and coordination with the Architect/Owner.

E. It is the Contractor's responsibility to receive approval of any changes from the design drawings deemed "minor changes" as outlined in Section 4.3.2 of DSA Policy PL 10-01 using the DSA change order process and appropriate addenda. For changes to the design drawings which alter the design of the system and require a Field Change Document (FCD) to be prepared, the preparation of the FCD shall be the responsibility of the Contractor and review will be provided by The Engineer of Record. Changes or modifications which do not modify the design of the system (such as addition of bracing or changes in specified material) shall be addressed using a DSA change order and shall require approval of the Architect/Owner.

F. Contractor shall field verify all site conditions and information contained on the contract drawings and is responsible for the complete design and installation of the system in accordance with the specifications. The contract drawings may not show all information

necessary for installation of the system, but are intended to be used by Contractor for the purpose of preparing a bid. The contract drawings indicate the following:

1. Hydraulically calculated pipe routing and sizes.
2. Types and minimum quantities of sprinklers and valves within the building.
3. Location of the new riser for the System and major points on the system.
4. NFPA Hazard Classifications
5. Seismic bracing calculations and attachment locations
6. Hanger locations
7. Building sections
8. System details
9. Additional information as required in the DSA AFSS Checklist.

G. There shall be no impairments to any of the adjoining building system in any way due to the work provided for in this Specification.

1.2 INTENT OF SPECIFICATIONS

A. The work performed pursuant to the Specifications is to be complete in every respect, resulting in the Systems installed in accordance with the applicable codes, standards, manufacturers' recommendations and Underwriters Laboratories Inc. (UL) Listings and/or Factory Mutual (FM) Global approval.

B. Upon completion of this work and as a part of this Contract, Contractor shall provide Architect/Owner with:

1. Complete information and 'as-built' record drawings describing and depicting the entire systems as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the system at a future date.
2. Complete documentation of the testing of the System Commissioning Authority and Authority Having Jurisdiction (AHJ) acceptance.
3. Certification that Contractor's work has been inspected and tested is installed entirely in accordance with the applicable codes, standards, manufacturers' recommendations and UL listings and/or FM approvals and is in proper working order. Contractor shall use "Contractor's Material and Test Certificate (s)" as required by NFPA codes.

1.3 WORK INCLUDED

A. General: Furnish all materials and labor for the design, installation, and testing of the new wet-pipe sprinkler system throughout the new building in accordance with all applicable codes and requirements of this Specification.

B. Provide personnel to inspect and verify piping and sprinkler locations as indicated in the bid drawings. The Contractor is responsible for any pipe routing changes, including offsets, required to install the new systems. Design changes must be approved by DSA.

C. Sprinkler: Furnish and install all components necessary for the automatic sprinkler system to result in a fully operational system. Provide appropriate water flow (pressure switch or vane type) and valve supervisory (tamper) to provide all monitoring of the System. Interface to the

new fire alarm system shall be completed by the Fire Alarm Contractor as specified in the Fire Alarm Specification.

D. Sprinkler Zones: Where shown on the drawings and/or detailed in the specifications, fire sprinkler system zoning and alarms shall correspond to alarm and detection and/or smoke control zones at a minimum, one sprinkler zone is required for each full floor.

E. Water supply for the building will be served from the existing firewater service from the existing public water main.

F. Drains: Provide all piped connections to the exterior of the building necessary to drain and test the sprinkler system. Drains shall terminate at the exterior of the building or when and where approved by Architect/Owner, at an interior drain capable of handling full flow conditions.

G. Provide updated record (as-built) drawings and hydraulic calculations to the Architect/Owner's Consultant for final approval. Also, provide updated hydraulic calculations, particularly if the construction condition deviates from the approved design. Changes must be reviewed and approved by DSA.

H. Shields: Install shields where necessary to protect electrical equipment from sprinkler discharge. Shields shall be such that water spray from sprinklers is shielded from the intended equipment only. Shields shall not completely block water spray over the remainder of the area to be protected. Coordinate with electrical drawings for these locations.

I. Valves: Furnish and install all system control valves, main and inspector's test drain valves and other appurtenances as required for a fully operable system. All system control valves shall be equipped with tamper switches for electronic supervision.

J. Painting: Painting of pipe and fittings shall be included throughout the building where the piping and fittings are exposed in public areas. The Contractor must coordinate with the Architect/Owner regarding color matching and adjacent architectural features. The Contractor shall include one coat of latex primer and one finished coat of latex paint. Pipe and fittings shall be painted red in mechanical and non-public areas (unless otherwise indicated on building plans or as directed by Architect/Owner) to indicate fire service use.

K. Submittals: Prepare and submit shop drawings, product data sheets, hydraulic calculations, record drawings and other submittals required herein. Work is not to proceed until all required submittals have been approved by Architect/Owner and all AHJ (if shop drawings differ from the DSA approved design). Contractor shall be responsible for the submission of the required materials to the Architect/Owner. If the shop drawings deviate from the approved design, the Contractor is responsible for resubmission to DSA.

L. Tests: Each new sprinkler system shall be tested in accordance with the requirements of NFPA 13, NFPA 24, AHJ and the Architect/Owner. The Sprinkler contractor shall also attend all fire alarm tests to aid in testing sprinkler system monitoring devices. Contractor shall be responsible for carrying out all required tests. Separate tests may be required by the Architect/Owner and AHJ.

M. Approvals: Obtain all approvals required for the work of this Section from all AHJ and Architect/Owner.

N. Fees: Pay all fees required to obtain permits, inspections and final approval of the work in this Section.

O. Coordination: Coordinate work with all other trades working on the project and with the other fire protection system specified elsewhere.

P. Unit Additions: Contractor shall provide unit pricing for any additional work or services.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. Underground Water Supply Piping: Water supply piping to a one-piece stainless steel riser with dielectric flange left plumb and level, six (6) inches above the finished floor at points shown on the bid drawings and documents. Size of flanges and underground supply mains are as shown. Project point of connection shall be 5'-0" outside the building line.

B. Alarms: Wiring and connection to the sprinkler system alarm and supervisory devices shall be provided by Fire Alarm Contractor as detailed in the Fire Alarm Specification.

C. Drains: Floor drains and other facilities for receiving discharge from system drains.

1.5 QUALITY ASSURANCE

A. All work shall conform to the requirements of the applicable editions and portions of the NFPA Standards, locally adopted codes, including:
   1. Title 24, Part 2, California Building Code (CBC) 2016 edition.
   2. Title 24, Part 3, California Electrical Code (CEC) 2016 edition.
   3. Title 24, Part 9, California Fire Code (CFC) 2016 edition.
   4. NFPA 13, 2016 edition, "Standard for the Installation of Sprinkler Systems"
   5. NFPA 24, 2016 edition, "Private Fire Service Mains and Their Appurtenances"
   6. NFPA 72, 2016 edition, "National Fire Alarm Code"
   7. All work and materials shall conform to all Federal, State, and local codes and regulations governing this installation including all parts of Title 24 statewide California codes.

B. Code Conflicts: Should conflicts exist between the referenced NFPA Standards, Federal, State or local codes and this Specification, it shall be Contractor's responsibility to bring the conflict to the attention of Architect/Owner for resolution. The Contractor shall not attempt to resolve code conflicts with the local authority, independent of Architect/Owner. In general, in the event of a conflict, the most stringent of the requirements will apply.

C. Permit Fees: Contractor shall be responsible for filing all documents, paying all fees and securing all permits, inspections and approvals necessary for completing the scope of the work in this Section.

D. Equipment: All devices, systems, equipment and materials furnished and installed shall be new and shall be submitted for approval by Architect/Owner. All sprinklers, pipe, fittings, hangers, valves, and other materials and equipment shall be UL listed and/or FM approved

for their intended use. All shall be acceptable to the AHJ when such agencies have listings of acceptable equipment.

E. Fittings: Fittings may be of the flanged, threaded, or grooved type. Welded outlets on cross-mains for riser nipples and/or branch lines and for sprinkler outlets on branch lines will be permitted. All shall be UL listed and/or FM approved for their intended use. The use of plain-end fittings to join steel pipe is not permitted.

F. Contractor Requirements: Contractor shall:
   1. Hold all licenses and obtain all permits necessary to perform work of this type in the state of California. Copies of Contractor's licenses shall be provided with bid submittal.
   2. Be regularly engaged for the past five years in the design, installation, testing and servicing of automatic sprinkler systems for buildings of this type.
   3. Contractor's site supervisor will be at the jobsite at all times when work is actively in progress
   4. Qualifications of Installer: Installer shall have a current C-16 license in the state of California for the installation of fire sprinkler systems. Pipe fitters shall be certified by the CAL FIRE – Office of the State Fire Marshal per OSFM Bulletin 17-002.

1.06 SPRINKLER SYSTEM DESIGN CRITERIA

A. Densities: Hydraulically designed and calculated sprinkler system shall be installed in accordance with the construction documents. The System has been designed to produce discharge densities of:
   1. 0.10 gpm/square foot over the hydraulically most remote 1,500 square feet in spaces designated as Light Hazard Occupancies.
   2. 0.15 gpm/square foot over the hydraulically most remote 1500 square feet in spaces designated as ordinary Hazard Group I Occupancies.
   3. 0.20 gpm/square foot over the hydraulically most remote 1500 square feet in spaces designated as ordinary Hazard Group II Occupancies.

B. Hose stream requirements: The calculations shall include a 100 gpm inside hose stream at the hose valve closest to the floor control valve assembly. The combined (inside and outside) hose stream for the calculations shall be 250 gpm.

C. Provide sprinklers throughout the facility including under ducts, stairs, and obstructions as required by NFPA 13. Base bids shall include 15 sprinklers in additions to those indicated in the drawing. A unit price for additional sprinklers under ducts, stairs, or other obstructions wider than 4 feet required but now shown on the construction documents, in excess of 15, shall be provided at the unit additional cost specified by the Contractor in the bid format sheets.

D. All branch line piping shall be minimum 1" nominal size. Branch line piping in gridded systems shall be minimum 1¼"nominal size. Threaded outlets on branch lines supplying sprinklers shall match the sprinkler threads, but shall be 1" NPT if supplying a sprig or drop.

1.07 SUBMITTALS

A. Shop Drawings: Contractor will be authorized to start the project or portions of the project when the shop drawings for the work are received, reviewed and approved by the design team. Installation prior to these approvals shall be at the Contractor's risk.
   1. Shop drawings shall show all of the information required by the applicable NFPA codes for working plans. Where the shop drawings depict changes from the approved design, the drawings shall also include the information outlined in DSA AFSS Submittal Guidelines for resubmission to DSA.
   2. Shop drawings shall include a drawing legend sheet identifying:
      a. All symbols used on the drawings by type of device or equipment, manufacturer and manufacturer's part number. This information shall correspond to the manufacturer's catalog data sheets and installation manuals.
      b. All conventions, abbreviations, and specialized terminology used on the drawings, as necessary to understand and interpret the information contained therein.
      c. A complete drawing list identifying all drawings in the shop drawing package by title, drawing number, and specification cross reference.
   3. Shop drawings shall be single line or architectural floor plan drawings, drawn to 1/8 inch equals one foot scale or larger (i.e., ¼-inch, etc.) showing a key plan and all other information required by the applicable NFPA codes for shop drawings.

B. Product Data: Contractor shall submit a product data submittal with the shop drawings. Manufacturers' Data Sheets shall show the type and model of all equipment or material proposed. This information shall include type of pipe, hangers, valves, pipe fittings/joining methods, air compressors, releasing panels, detection equipment, sprinklers, water flow devices, supervisory devices, Fire Department Connections, escutcheons, and signage. When a Data Sheet shows more than one product, the specific proposed product shall be clearly indicated by arrows or other suitable means. All manufacturers' data sheets shall clearly show all UL listings and/or FM approvals for each product submitted.

C. Contractor shall provide hydraulic calculations in accordance with the requirements of NFPA 13, showing that the pipe sizes provided will produce adequate performance where the Contractor's design deviates from that approved by DSA. A minimum safety factor of 10 psi or 10%, whichever is greater of the available pressure at the required system flow (including all required hose stream demands) shall be demonstrated in the hydraulic calculations.

D. Two sets of shop drawings, product data sheets, and hydraulic calculations as described in parts A, B, and C shall be submitted to Architect/Owner for review. Only complete submittals containing all required information for all work required in this Section will be reviewed. Incomplete submittals will be returned to Contractor without being reviewed.

E. All drawings and diagrams shall be prepared on drawing sheets of uniform size, 30 by 42 inches minimum and shall contain no extraneous information. Marked up electrical, HVAC or similar drawings or copies of catalog data sheets are not acceptable in lieu of the required drawings or diagrams. All other information required for this submittal shall be submitted in one or more appropriately labeled (i.e., Contractor's name, project, submittal name/description and date) and indexed in 3-ring binders.

F. All drawings and diagrams shall include Contractor's title block, complete with drawing title, Contractor's name, address, date including revisions, and preparer's and reviewer's initials. All drawings and diagrams shall be reviewed and stamped as required by the AHJ.

G. Samples: Within 30 days of authorization to proceed, Contractor shall submit to Architect/Owner for approval, samples of all types of proposed sprinklers, including types of finishes available and a complete list of where each type and finish will be installed.

H. Prior to start of installation, Contractor shall submit copies of all permits and approvals to Architect/Owner necessary to conduct this work. A minimum of one complete set of such permits and approvals shall be kept by Contractor at the jobsite and shall be available for review.

I. Contractor shall provide Architect/Owner with one copy of all documents that are reviewed and approved by the AHJ and/or local code authorities. These documents shall include, but not be limited to the following:
   1. Site inspection forms
   2. Shop drawings
   3. Final inspection forms
   4. Workers' Compensation insurance

   All documents shall include all required approval stamps, signatures or other information necessary to properly certify that the installation has been reviewed and accepted by the AHJ.

J. Operation and Maintenance (O&M) Manual: The Contractor shall provide Architect/Owner with an indexed 3-ring binder containing:
   1. 11"x17" reduced copies of the 'as-built' record drawings required below (Final submittal only)
   2. Manufacturers' catalog data sheets and installation manuals
   3. Copies of all test certificates and approvals
   4. A list of recommended spare parts and summary of spare parts provided
   5. A service directory, including a list of Contractor's contact names and telephone numbers for service on the system, including emergency service as required elsewhere in these Specifications.

K. Draft O&M Manual: Within 30 days following the notice of authorization to proceed, Contractor shall submit to Architect/Owner three copies of the draft manual for approval, excluding test certificates and drawings. The draft manual will be reviewed for required content and approved or disapproved on that basis. Upon completion of the project, Contractor shall revise the approved preliminary manual to reflect the systems as installed and to coordinate the testing and maintenance schedule with the approved Contractor testing protocols. Any and all assigned fire protection device numbers shall also be indicated on the Contractor's record drawings.

L. Final O&M Manual: Within 30 days of the completion of the work, two final copies of the approved manual with reduced drawings and test certificates shall be delivered to the Architect/Owner.

M. Record Drawings: Contractor shall provide and maintain on the site an up-to-date 'as-built' record set of approved shop drawing prints which shall be marked to show each and every change made to the wet-pipe sprinkler and standpipe systems from the original approved shop drawings. This requirement shall not be construed as authorization to deviate from or make changes to the shop drawings approved by Architect/Owner without written instruction from Architect/Owner in each case. These drawings shall be maintained in a current condition at

all times and shall be made available for review immediately upon request during normal working hours throughout the installation.

N. Upon completion of the 'as-built' record drawings and before final approval, one set of reproducible 'as-built' record drawings shall be delivered to Architect/Owner. Upon approval by Architect/Owner, two sets of final record drawing shall be furnished to Architect/Owner. In addition, a record set of drawings shall be transmitted to Architect/Owner in the latest version of AutoCAD electronic format with any applicable executable, unarchiving files.

O. If Contractor's submittals, upon review by Architect/Owner, do not conform to the requirements of these specifications, Contractor shall be required to resubmit with modifications, within ten (10) working days of receipt of Architect/Owner's notification to Contractor. Contractor shall be responsible for Architect/Owner's expenses for subsequent review of rejected submittals that were necessitated by Contractor's failure to make the requested modifications. Such extra fees shall be deducted from payments by Architect/Owner to Contractor.

P. Commissioning pre-functional and functional checklists shall be completed with all supporting documentation prior to Architect/Owner acceptance.

1.08 WARRANTY AND EMERGENCY SERVICE.

A. Contractor shall warrantee all materials and workmanship for a period of two (2) years beginning with the date of final acceptance of Contractor's completed installation by Architect/Owner. Contractor shall be responsible during the design, installation, testing, and warranty periods for any damage caused by Contractor (or its subcontractors) or by defects in Contractor's (or its subcontractors) work, materials, or equipment.

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

1.09 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts and special tools shall be provided to Architect/Owner prior to final acceptance and shall be provided for each system riser location.

B. Spare Parts: Contractor shall install UL listed and/or FM approved spare sprinkler cabinets containing a minimum quantity of sprinklers of each type, finish and temperature rating used in accordance with the requirements of NFPA 13, but not less than six (6) spare sprinklers. Contractor shall provide two (2) sets of sprinkler wrenches compatible with each type of sprinkler provided in each cabinet. The cabinets shall be installed near the system riser at a location approved by Architect/Owner. Contractor shall provide as many sprinkler cabinets as necessary to accommodate the required number of spare sprinklers, but a minimum of one spare cabinet per sprinkler riser location shall be provided.

C. Special Tools: Contractor shall supply Architect/Owner with two complete sets of special tools and equipment necessary to perform routine maintenance on the sprinkler systems.

1.10 FINAL ACCEPTANCE

A. Date of Final Acceptance will be established by Architect/Owner and shall be based on acceptance of the installation and required approved documentation by Architect/Owner and AHJ.

1.11 ADDITIONAL WORK

A. Prior to award of the Automatic Fire Sprinkler system contract, the Contractor shall provide the Architect/Owner with unit pricing and/or allowances for additional work that may be required beyond the scope of work shown on the contract documents to meet NFPA and CBC requirements. If unit pricing and/or allowances are not provided, the installing contractor shall not be reimbursed for additional work provided.

B. Provide sprinklers throughout the facility including under ducts, stairs, and obstructions as required by NFPA 13. A unit additional price for sprinklers under ducts, stairs, or other obstructions wider than 4 feet required but not shown on the construction documents in excess of 15 shall be provided at the unit additional cost specified by the Contractor in the bid format sheets. Base bid shall include 25 sprinklers in additions to those indicated in the drawing.

PART 2 – SYSTEM REQUIREMENTS

2.1 GENERAL

A. All equipment and system components furnished and installed shall be new and of first quality and be UL listed and/or FM approved for their intended use. All such equipment and system components shall be installed in accordance with the respective UL listings, FM approvals and California State Fire Marshal approved. All materials shall be acceptable to the Architect/Owner and the AHJ.

2.2 PIPE AND FITTINGS – GENERAL

A. Pressure ratings: Pressure ratings of all fittings shall meet or exceed maximum working pressures available within the system.

B. Corrosion protection: All piping and hangers, where exposed to the weather or installed in a corrosive atmosphere shall be protected against corrosion. Piping and hangers in such areas shall be stainless steel and/or hot dipped galvanized. Piping having an external only galvanized finish in such areas is unacceptable.

2.3 ABOVEGROUND PIPING COMPONENTS

A. Pipe Sizes 2.5 inches (65mm) and larger:

1. Piping shall be ASTM A-53/A – 135/A-795, Weight Class STD (Standard), Schedule 40, Type E or Type S, Grade A; black steel pipe. Steel pipe shall be joined by means of flanges welded or screwed to the pipe, threaded fittings or grooved couplings only. Piping shall not be joined by welding or weld fittings.

B. Piping Sizes 2 inches (50 mm) and Smaller
   1. Steel Pipe: Steel piping shall be ASTM A-53/A – 135/A-795, Weight Class STD (Standard), Schedule 40, Type E or Type S, Grade A, steel pipe with threaded end connections. Fittings shall be ASME B16.39, Class 150, cast or ductile iron threaded fittings. Unions shall be ASME B16.39, Class 150 unions. Pipe may also be joined using grooved couplings and fittings. Where grooved joining is used, cut or rolled grooves are acceptable.
   2. Post-chlorinated Poly Vinyl Chloride (CPVC) shall not be acceptable.

C. Pipe Hangers and Supports
   1. Pipe hangers and supports shall be UL listed, FM approved, and California State Fire Marshal approved for fire protection use and shall be installed in accordance with their listings and manufacturers' recommendations. Type, quantity, and spacing shall be in accordance with the requirements for the specific seismic zone requirements and those of NFPA.

2.4 CONTROL AND DRAIN VALVES

A. Sprinkler system control and drain valves shall be the following types:
   1. OS&Y, gate valves
   2. Post indicator valves shall be direct buried, made of cast iron body, resilient wedge construction, fusion epoxy lined and coated, non-rising stem with cast iron body, adjustable type and conforming to AWWA specifications. Post indicator shall be cast iron body, adjustable type, and include non-breakable plastic windows to indicate the valve position. A Post indicator valve shall have an operating wrench attached to the post indicator. Valves are to be locked in the open position.
   3. Butterfly valves with gear operator assembly and open/closed position indicator. Butterfly valves shall have an integrated, factory-installed supervisory (tamper) switch.
   4. Brass seated, straight-way or angle globe valves for main drain and inspector's test. System Gauges shall be riser mounted to ¼ inch, three-way globe valves.
   5. Riser check valve: A riser check valve shall be provided on the building water supply riser, prior to the Fire Department Connection. The riser check valve shall have a cast iron body and shall be of the "swing check" type/style. Wafer type check valves will not be permitted.

B. All valves must be UL listed, FM approved, California State Fire Marshal approved for their intended use.

C. Signs: All water supply control valves and drain valves shall be marked with metal signs and shall be secured with metal chains or other means approved by Architect/Owner and AHJ to show their function and sprinkler system zone which they serve. Attachment of signs to the valves with adhesives is not permitted.

D. Pressure Ratings: Pressure ratings of all valves shall meet or exceed maximum working pressures available within the system.

E. Supervision: All system control valves shall be capable of being locked in the open position. System control valves shall be equipped with electronic supervisory (tamper) switch having two normally open contacts (rated for 24vdc service) and shall be electrically supervised by the building fire alarm system.

F. Access Panels: Furnish and install access panels (minimum size 12 inches by 12 inches) for all control valves located above finished ceilings or concealed in walls. Architect/Owner will select finish of access panels. Access panels installed in fire resistive construction shall be of the types required for maintaining proper protection of assembly.

G. Valves and assemblies that are exposed to potential damage by vehicles or other traffic are to be protected by providing a cage or other approved barrier when located inside the building.

2.5 ELECTRICAL WORK

A. Furnish all labor, equipment and services necessary for the design and installation of required connections as required to complete fully operational system. Contractor will be responsible for the mounting of all water flow, tamper, and pressure switches for the fire protection systems in this Section. Ring of such devices is outside the scope of this Specification. Wiring of such devices is included in the Fire Alarm Specification and is the responsibility of the Fire Alarm contractor.

B. Service: Confirm power connections with electrical contractor.

C. Testing: Provide the required assistance to the Fire Alarm Contractor to test, adjust and place the fire protection system into initial operation.

2.6 SPRINKLERS

A. Contractor shall furnish and install fire sprinklers of the following types and finishes.
   1. Concealed Quick-Response pendent sprinklers shall be installed in all public areas. Concealed sprinklers shall be UL listed or FM approved assembly. Concealed plate finish shall be factory painted to match the ceiling on which it is installed unless otherwise directed by the Architect/Owner in the submittal process.
   2. Quick-Response sidewall sprinklers shall be installed in the elevator pit where combustible hydraulic fluid is present. Sidewall sprinklers shall be UL listed or FM approved assembly and the escutcheon shall be integral to the sprinkler. Finish shall be brass for the sprinkler and escutcheon unless otherwise directed by the Architect/Owner in the submittal process.
   3. Quick-Response upright or pendent sprinklers shall be installed in non-public, unfinished areas. Sprinkler finish shall be brass unless otherwise directed by the Architect/Owner in the submittal process.
   4. Quick-Response upright or pendent with cage guards, shall be installed in areas subject to damage (e.g., under stairs and mechanical rooms). Fusible link style sprinklers shall be acceptable in areas subject to damage. Sprinkler finish in such areas shall be brass, unless otherwise directed by the Architect/Owner in the submittal process.
   5. Window sprinklers shall be installed to protect glazed openings in fire rated walls.

B. Final Selection: Architect/Owner will select finishes for all automatic sprinklers and escutcheons.

C. Uniformity: All sprinklers within a space shall be from the same manufacturer and shall have the same type and style of heat response element, including temperature rating and response characteristics.

D. Temperature Rating: It shall be Contractor's responsibility to install sprinklers of the proper temperature rating as required by NFPA 13.

E. Corrosion Resistance: Sprinklers located on exterior piping systems or in areas exposed to corrosive atmospheres shall be UL listed and/or FM approved corrosion resistant coated or stainless steel.

F. Sprinkler Escutcheons: Flush sprinkler escutcheons shall be metal and shall be listed for use with the sprinklers. Recessed sprinklers and escutcheons shall be UL listed and/or FM approved as an assembly and the sprinkler and escutcheon shall be of the same manufacturer.

G. Penetrations through the ceiling for sprinklers that are not integrally tied to the ceiling system in the lateral direction shall have a two (2) inch oversized ring, escutcheon, or cover plate through the ceiling tile to allow free movement of one (1) inch in all horizontal directions per ASTM E580.

H. Sprinkler Orifice: Sprinkler orifice sizes shall be confirmed through hydraulic calculations for the system. Sprinklers having a nominal "K" factor of less than 5.6 are not acceptable unless specifically allowed by NFPA 13. The orifice size shall be uniform within a protected area.

I. All sprinklers in finished areas shall be center of tile plus or minus 2 inches, unless approved by the Architect/Owner. All sprinklers shall be aligned in all directions when multiple sprinklers are in the same area and are in the same line of sight. Contractor shall coordinate location of all sprinklers in finished areas with Architect/Owner. Where acceptable to AHJ, the use of flexible drops is permitted, but all such drops must be installed in accordance with their UL listings and/or FM approvals. Where such listings/approvals differ, the most stringent installation requirements will apply. The use of flexible drops shall be accounted for in all hydraulic calculations for the system. Flexible drops shall be of the braided, stainless steel hose style. Flexible drops employing corrugated steel tubing will not be permitted.

J. Sprinklers installed in suspended ceilings shall comply with DSA IR 25-2.12 and IR 25-3.13.

2.7 IDENTIFICATION SIGNS

A. Contractor shall furnish and install hydraulic calculation signs for each new sprinkler zone. Hydraulic calculation signs shall be affixed to the corresponding system riser downstream of the system control valve and main drain at the riser. Contractor shall also provide identification signs for all valves installed under this Section.

B. Hydraulic calculation signs shall include all information indicated in NFPA 13 and its appendices. Valve identification signs shall identify the function of the valve and the area served.

C. Identification signs shall be rigid, metal plaques with embossed enamel background and lettering. Signs shall be secured by chain or durable wire to each sprinkler zone control valve, main and auxiliary drain and inspector's test valve. System hydraulic calculation placards affixed using adhesives and/or using permanent marker for information are NOT acceptable.

2.8 FIRE DEPARTMENT CONNECTION AND HOSE EQUIPMENT

A. Fire Department Connections: Fire Department Connection (FDC) shall be located in accordance with code and jurisdiction requirements. As shown on the civil documents, the Fire Department Connection shall serve the system riser as required by the CFC and NFPA 13. The number of 2-1/2 inch inlets shall be as required by NFPA and Contractor shall match threads to the requirements of the local fire department the FDC shall have a brass cast body. The FDC shall be a yard-mounted style and shall be brass, polished chrome, safety yellow painted finish and shall be complete with matching trim ring of the same finish. The trim ring will be clearly marked for the service – Automatic Sprinklers. Outlets will be equipped with threaded caps of matching finish and such caps will be attached to the FDC with chains of the appropriate finish. The FDC and appurtenances will be of a single manufacturer and the unit will be UL listed and California State Fire Marshal approved for its intended service and acceptable to Architect/Owner and AHJ.

2.9 SUPERVISORY AND ALARM EQUIPMENT

A. All water flow and valve supervisory switches shall be furnished, installed and properly adjusted by the sprinkler contractor. Alarm monitoring of these devices will be by others.

B. Contacts: All water flow and valve supervisory switches shall be provided with two "Form C" (D.P.D.T.) contacts for monitoring. Specific contact rating shall be coordinated with the fire alarm contractor.

C. Water flow Switches: Vane-type and/or pressure-type water flow indicators shall be provided to indicate water flow in each sprinkler system zone and shall be UL listed and/or FM approved. All water flow switches shall be equipped with an adjustable retard setting that can be varied from 0 to 60 (minimum) seconds.

D. Supervisory Switches: Valve supervisory (tamper) switches shall be provided for all valves controlling the water supply to the sprinkler systems. Valve supervisory switches for OS&Y type valves shall be the yoke mounted or integral type. Supervisory switches for butterfly style valves shall be factory installed and integral to the valve assembly.

1.10 INSPECTOR'S TEST AND DRAIN ASSEMBLY

A. The inspector's test and drain assembly shall be installed downstream of the water flow alarm device as permitted by NFPA 13. The discharge of the inspector's test valve and drain shall be at a location approved by the Architect/Owner.

B. The inspector's test and drain assemblies shall comply with the requirements of NFPA 13. All components of test and drain assemblies shall be UL listed and/or FM approved.

2.11 MISCELLANEOUS PRODUCTS

A. Pressure Gauges: Pressure gauges shall be UL listed 3-1/2 inch minimum diameter, dial type gauges with a maximum limit of not less than twice the normal working pressure at the point installed. All gauges shall be provided with¼ inch, 3-way shut-off valve (gauge-cock).

PART 3 – EXECUTION

3.1 WORKING CONDITIONS

A. Contractor shall visit the site and become familiar with the conditions under which the work will be performed.

3.2 PREPARATION FOR WORK

A. Cooperation with other trades: Contractor shall coordinate with the work of the other trades towards the general purpose of having the construction progress as rapidly and as smoothly as possible with a minimum of interference between trades.

B. Before the start of Structural Work, Contractor shall submit to Architect/Owner locations, sizes, and instructions for openings and penetrations required for his work. Submittal and proposed penetrations shall be subject to Architect/Owner. In general, penetrations of primary structural members are not permitted.

C. Approval prior to installation: No work shall commence prior to approval of shop drawings by the approving authorities, including Architect/Owner. Any change in work that has been installed prior to approval of the shop drawings shall be made without additional compensation to Contractor.

3.3 GENERAL INSTALLATION

A. Aesthetics shall be a primary consideration when installing sprinklers and sprinkler piping in all areas. Any facet of sprinkler installation that deviates from the approved shop drawings and does not meet with Architect/Owner's approval shall be revised by Contractor to Architect/Owner's satisfaction at no additional cost.

B. All holes made by Contractor in any wall, ceiling, or floor shall be patched by Contractor, restoring the wall, ceiling, floor or member to its intended condition, fire resistance, and integrity.

C. Location of all equipment, controls, piping, valves and drains shall be subject to Architect/Owner's approval.

D. All sprinklers and equipment shall be installed in accordance with manufacturers' instructions. All special tools including sprinkler wrenches, recommended by the manufacturer shall be used.

E. Sprinklers shall be installed with the deflector to ceiling distances in accordance with their UL listings and/or FM approval and the requirements of NFPA 13.

3.4 PIPING

A. All sprinkler piping installed in public areas or non-public areas with suspended ceilings shall be concealed in the walls, ceilings or soffits. Pipe in unfinished areas may be exposed.

B. All piping exposed within the building public areas shall be painted with one coat by Contractor. Architect/Owner is to select the colors. All exterior piping shall be primed with zinc chromate and painted by Contractor.

C. Escutcheon Plates: All exposed pipe which passes through a wall, ceiling, or floor shall be provided with metal escutcheon plates.

D. Minimum Height: All exposed piping and devices shall be installed as high as possible, but no less than seven (7) feet clear above the finished floor in traffic or working areas, so as not to obstruct any portion of a window, doorway, stairway or passageway. Pipe and fittings shall not interfere with the operation or accessibility of any mechanical, plumbing or electrical equipment.

E. Operating Chains: Valves controlling water supply to the sprinkler systems shall be less than seven (7) feet above the finished floor. When specifically approved by Architect/Owner, they may be higher and must be provided with operating chains.

F. Protection: Contractor shall provide Architect/Owner approved, adequate permanent protection for any installed piping, valves, devices or accessories which in Architect/Owner's opinion, are subject to physical damage or may be hazards.

G. Firestopping: Pipe that passes through fire-rated resistive barriers (including shaft walls) shall be sleeved and grouted or sealed with a UL listed through-penetration fire stop system to maintain the integrity and rating of the fire resistive barrier.

H. Testing: All piping is to be flushed and hydraulically tested prior to acceptance by Architect/Owner. Flushing and testing must be performed in accordance with NFPA standards.

I. The Contractor shall provide all equipment necessary for testing and flushing and any special equipment required for the installation of any portion of sprinkler system. Contractor shall remove all such equipment at the end of the job.

J. All above ground piping 2-1/2" and larger shall be provided with labels at 20-foot intervals indicating sprinkler system piping.

3.5 SYSTEM TEST AND DRAIN CONNECTIONS

A. Contractor shall provide all test valves and drain connections as required by NFPA 13.

B. All test connections and drain riser connections shall be hard piped to discharge waste water to the exterior of the building or as required by the AHJ. When acceptable to

Architect/Owner, drain piping may terminate at an interior drain of sufficient size and capacity to accommodate the anticipated maximum flow. The sprinkler contractor shall coordinate routing of the drain pipe and points of discharge.

3.6 RISERS

A. Contractor shall locate the main risers for the sprinkler system to minimize obstruction or traffic or building operations.

B. Zoning: The fire sprinkler system shall be zoned on a per floor basis and divided into zones as noted herein (and/or on the riser diagram shown on the contract drawings). Sprinkler zones shall not exceed the maximums specified in NFPA 13. Sprinkler zoning (and alarms) will also conform to alarm and detection and/or smoke control system zoning.

C. Supervisory Switches: Valve supervisory switches shall be provided on all valves controlling water supply to the fire sprinkler system, including valves located at backflow preventers.

3.7 CLEANLINESS

A. All equipment and materials prior to installation shall be clean inside and outside. All waste material such as chips, filings, welding stubs, dirt, rags, debris, and any other foreign material shall be removed from the components before assembly.

B. All steel pipe coupons or punched holes for welded or mechanical outlets shall be attached to the pipe near the pipe hole. Protective plastic caps shall be located over openings and pipe ends during installation to prevent foreign material from entering the pipe at any time.

3.8 SEISMIC CONSIDERATIONS

A. Sprinkler piping on any floor level may cross building structural separations such as expansion and seismic joints, provided that the piping is specifically designed with flexible connections at each crossing and able to accommodate the calculated differential motions during an earthquake, but not less than a minimum of 24 inches. All required structural, differential movement and drift calculations shall be prepared by a licensed structural engineer possessing current California registration. The seismic separation assembly shall be Metraflex Fire loop, as indicated on the design drawings. Contractor shall verify locations of seismic joints.

3.9 SWAY BRACING, FLEXIBLE COUPLINGS, HANGERS

A. All flexible couplings, hangers and sway bracing shall be designed and installed as required by NFPA 13 (including all appendices) and in accordance with their listings and/or approvals. Flexibility, internal pressure and differential movement between the piping and building, earth, or other supporting structure shall be allowed for, so that no allowable stress is exceeded in any member.

3.10 TRAINING

A. Contractor shall conduct two (2) training sessions of four (4) hours each at the project site to familiarize the building personnel with the features, operation and maintenance of the sprinklers. Training sessions shall be scheduled by Architect/Owner at a time mutually agreeable to Contractor and Architect/Owner.

B. Agenda: Contractor shall submit a proposed training agenda for Architect/Owner's review and approval within 60 days of receipt of authorization to proceed. The proposed training agenda shall include, but not be limited to the following:
   1. Overview of system operation
   2. Overview of system equipment and device locations
   3. Detailed operation guidelines
   4. Detailed maintenance procedures
   5. Periodic testing procedures

C. Final Agenda: Contractor shall submit the final approved training agenda 14 days prior to the first training session.

3.11 FINAL INSPECTION AND TEST

A. Contractor shall make arrangements with Architect/Owner for Architect/Owner's final inspection and witnessing of the final acceptance tests. This test shall be separate from testing by the local authorities.

B. All tests and inspections required by the referenced Codes and Standards, AHJ, and Architect/Owner shall be conducted by Contractor under this scope of work.
   1. When AHJ are required to witness tests, Contractor shall be responsible for making all necessary arrangements with the code authorities and coordinating the testing with Architect/Owner.
   2. Contractor shall be responsible for completing all test documents with necessary approval stamps and signatures of the AHJ. Contractor shall submit one copy of each of these documents to Architect/Owner for their records.

C. Acceptance Testing: Upon completion of each system, perform and document on an NFPA or approved format, system tests as described herein. All acceptance tests shall be performed in the presence of Architect/Owner.
   1. Hydrostatic tests.
   2. Flushing of piping
   3. Test of sprinkler supervisory system – The Alarm and Detection Contractor should be present at the testing of all sprinkler alarm and supervisory devices. This Contractor shall coordinate the final testing of all such devices with the Alarm and Detection Contractor.

D. Contractor shall provide at least five (5) working days' notice for all tests to all involved.

3.12 FINAL APPROVAL

A. Final approval and acceptance of the work will be given by Architect/Owner when:
   1. The completed sprinkler system has been inspected, tested and approved by Architect/Owner and AHJ.
   2. Required submittals, system operation and maintenance manuals, record drawings, spare parts, special tools and training have been provided to be reviewed and accepted by Architect/Owner.
   3. Written certification is submitted that states all equipment has been inspected and tested by a manufacturer's certified representative.
   4. Written certification is submitted that states all equipment has been inspected and tested by a manufacturer's certified representative.

B. Architect/Owner's Representative may visit the jobsite to observe the work and witness the final acceptance tests when advised by Contractor that the work is complete and ready for testing. If the work has not been completed or the test is unsatisfactory, Contractor shall be responsible for Architect/Owner's added expenses for re-inspection and witnessing the retesting of the work. Such extra fees shall be deducted from payments by Architect/Owner to Contractor.

C. Additional Tests: Any additional tests required by the referenced codes, standards, or criteria, or by Architect/Owner shall be performed. This documentation shall include:
   1. The date and time of each test
   2. A reference set of contractor record drawings, numerically identifying the individual components and circuits tested and test locations.
   3. A description of each test performed
   4. A checklist of each device tested indicating the results of each test
   5. The names and signatures of the individuals conducting and witnessing each test.

3.13 FIELD QUALITY CONTROL

A. Scheduling of Work:
   1. Coordinate the installation schedule for this portion of the work with the overall construction schedule for the project to ensure orderly progress of the work without delay.
   2. Coordinate the interface of the automatic sprinkler system with the work of all other trades as well as new construction to ensure proper and adequate provision for the installation and connection of this system.

3.14 HOUSEKEEPING

A. Upon completion of the work the Contractor will completely remove all debris and excess materials from the jobsite.

3.15 GUARANTEE PERIOD

A. Except as otherwise expressly provided in the Contract Documents and excepting only items of routine maintenance, ordinary wear and tear or unusual abuse or neglect, Contractor guarantees all work executed by Contractor and all supplies, materials, and devices of

whatsoever nature incorporated in, or attached with the work, or otherwise delivered to the Architect/Owner as part of the work pursuant to the contract to be absolutely free of all defects of workmanship and materials for a period of one year after final acceptance of the work by Architect/Owner's representative.

B. Include service directory with telephone numbers for 24-hour emergency service.

END OF SECTION 211313

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SECTION 220500 - 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. Mechanical sleeve seals.
   4. Sleeves.
   5. Escutcheons.
   6. Grout.
   7. Plumbing demolition.
   8. Equipment installation requirements common to equipment sections.
   9. Concrete bases.
   10. Supports and anchorages.

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. General Plumbing piping: All plumbing work shall be in accordance with 2016 California plumbing code, part 5, Title 24, CCR.

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

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. 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.

E. Commissioning
   1. Commissioning requires the participation of Division 22 plumbing contractor to work to ensure that all systems are operating in a manner consistent with the construction documents and the design intent. The general commissioning requirements and coordination are detailed in Division 1 and in Division 23. This Division shall be familiar with all parts of Division 1 and Division 23 and the commissioning plan issued by the Commissioning Authority and shall execute all commissioning responsibilities assigned to them in the Contract Documents.
   2. The plumbing contractor is responsible for assisting the commissioning agent throughout the entire commissioning process on the work under their section. The work is not complete until the commissioning agent and the College has signed off on the commissioned systems.

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

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

E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12.

G. Solvent Cements for Joining Plastic Piping:
1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

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 MECHANICAL SLEEVE SEALS

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

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

C. Pressure Plates: Carbon steel. Include two for each sealing element.

D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 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 water stop, unless otherwise indicated.

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

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

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

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 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.

2.7 GROUT

A. Description: ASTM C 1107, 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.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

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

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

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

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

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

Q. Verify final equipment locations for roughing-in.

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

3.3 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.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   5. PVC Non-pressure Piping: Join according to ASTM D 2855.
   6. PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D 3138 Appendix.

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

3.5 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.

3.6 CONCRETE BASES

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

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES.

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

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

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

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

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

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

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

3.9 GROUTING

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

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

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

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

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 220500

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SECTION 220516 – EXPANSION PIPE FITTINGS AND LOOPS FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Stainless Steel-bellows type expansion joints.
   2. Pipe loops and swing connections.
   3. Alignment guides and anchors.

1.2 SUBMITTALS

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

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 swing connections.
   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. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

A. Stainless Steel Bellows Type Expansion Joints:
   1. Manufacturers: available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
      a. Metraflex Inc.

b. American BOA, Inc.
c. Badger Industries, Inc.
d. Expansion Joint Systems, Inc.
e. Flex-Hose Co., Inc.
f. Flexicraft Industries.
g. Flex Pression Ltd.
h. Flex-Weld, Inc.
i. Flo Fab inc.
j. Hyspan Precision Products, Inc.
k. Adsco Manufacturing LLC Proco Products, Inc.
l. Universal Metal Hose; a subsidiary of Hyspan Precision Products, Inc.
m. U.S. Bellows, Inc.

3. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
4. Type: Circular, corrugated bellows with external tie rods.
5. Minimum Pressure Rating: 150 psig unless otherwise indicated.
6. Configuration: Single joint class unless otherwise indicated.
7. Expansion Joints for Copper Tubing: Single phosphor-bronze bellows, copper pipe ends, and brass shrouds.
   a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint.
   b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint.
   c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.

2.2 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:
   1. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:
   1. Steel Shapes and Plates: ASTM A 36/A 36M.
   2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
   3. Washers: ASTM F 844, steel, plain, flat washers.
   4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
      a. Stud: Threaded, zinc-coated carbon steel.
      b. Expansion Plug: Zinc-coated steel.
      c. Washer and Nut: Zinc-coated steel.
   5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
      a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
      b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
      c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

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

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install two guides on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. 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.

E. Anchor Attachments:
   1. Anchor Attachment to Black-Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   2. Anchor Attachment to Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.
   3. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
   1. Anchor Attachment to Steel Structural Members: Attach by welding.
   2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 220516

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sleeves.
   2. Sleeve-seal systems.
   3. Grout.

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

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

2.2 SLEEVE-SEAL SYSTEMS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Metraflex Inc.
   2. CALPICO, Inc.
   3. Advance Products & Systems, Inc Pipeline Seal and Insulator, Inc.
   4. Proco Products, Inc.

5. Or Approved equal.

C. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
1. 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.

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

D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller than NPS 6 Cast-iron wall sleeves.
      b. Piping NPS 6 and Larger: Cast-iron wall sleeves.

   2. Exterior Concrete Walls below Grade:
      a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

      b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   3. Concrete Slabs-on-Grade:

      a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

      b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   4. Concrete Slabs above Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
      b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

   5. Interior Partitions:
      a. Piping Smaller than NPS 6 Galvanized-steel-pipe sleeves.
      b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

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

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

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type.

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

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 220518

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Liquid-in-glass thermometers.
   2. Dial-type pressure gages.
   3. Gage attachments.

1.2 SUBMITTALS

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

B. Product certificates.

C. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Flo Fab Inc.
      b. Miljoco Corporation.
      c. Palmer Wahl Instrumentation Group.
      d. Tel-Tru Manufacturing Company.
      e. Trerice, H. O. Co.
      f. Weiss Instruments, Inc.
      g. Winters Instruments - U.S.
      h. Or Approved equal.

   3. Standard: ASME B40.200.
   4. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
   5. Case Form: Adjustable angle unless otherwise indicated.
   6. Tube: Glass with magnifying lens and blue or red organic liquid.
   7. Tube Background: Non-reflective aluminum with permanently etched scale markings graduated in deg F (deg C).
   8. Window: Glass.

9. Stem: Aluminum and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
10. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
12. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    a. Ernst Flow Industries.
    b. Marsh Bellofram.
    c. Miljoco Corporation.
    d. Palmer Wahl Instrumentation Group.
    e. REOTEMP Instrument Corporation.
    f. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
    g. Weiss Instruments, Inc.
    h. WIKA Instrument Corporation - USA.
    i. Or Approved equal.
13. Standard: ASME B40.200.
14. Case: Plastic; 7-inch (178-mm) nominal size unless otherwise indicated.
15. Case Form: Adjustable angle unless otherwise indicated.
16. Tube: Glass with magnifying lens and blue or red organic liquid.
17. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
18. Window: Glass.
19. Stem: Aluminum and of length to suit installation.
    a. Design for Thermowell Installation: Bare stem.
20. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
21. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings or comparable product by one of the following:
   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Ernst Flow Industries.
   d. Flo Fab Inc.
   e. Marsh Bellofram.
   f. Miljoco Corporation.
   g. Noshok.
   h. Palmer Wahl Instrumentation Group.
   i. REOTEMP Instrument Corporation.
   j. Tel-Tru Manufacturing Company.
   k. Trerice, H. O. Co.
   l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.

m. Weiss Instruments, Inc.
n. WIKA Instrument Corporation - USA.
o. Winters Instruments - U.S.
p. Or Approved equal.

3. Standard: ASME B40.100.
4. Case: Liquid-filled; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
5. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
6. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
9. Pointer: Dark-colored metal.
10. Window: Glass.
11. Ring: Metal.
12. Accuracy: Grade A, plus or minus 1 percent of middle half of Grade B scale range.

2.3 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending [a minimum of 2 inches into fluid one-third of pipe diameter to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

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

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install thermometers in the following locations:
1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of each remote domestic water chiller.

K. Install pressure gages in the following locations:
1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

L. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

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

3.2 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
1. Liquid-filled Sealed, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

B. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be[one of] the following:
1. Liquid-filled Sealed, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

C. Thermometer stems shall be of length to match thermowell insertion length.

3.3 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F.

B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F.

3.4 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:
1. Liquid-filled Sealed Solid-front, pressure-relief -mounted, metal case.
2. Sealed, direct -mounted, plastic case.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
1. Liquid-filled Sealed Solid-front, pressure-relief, direct-mounted, metal case.

2. Sealed, direct remote-mounted, plastic case.

C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
1. Liquid-filled Sealed Solid-front, pressure-relief direct -mounted, metal case.
2. Sealed, direct -mounted, plastic case.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Water Piping: 0 to 160 psi.

B. Provide with minimum 2 year warranty.

END OF SECTION 220519

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SECTION 220523 - GENERAL DUTY VALVES FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Brass ball valves.
   2. Bronze ball valves.
   3. Bronze swing check valves.
   4. Bronze gate valves.
   5. Bronze globe 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.
   3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

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. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Gate Valves: With rising stem.

2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

E. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

2.2 BRASS BALL VALVES

A. Three-Piece, Full-Port, Brass Ball Valves with Brass Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Nibco Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. DynaQuip Controls.
e. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
f. Hammond Valve.
g. Jamesbury; a subsidiary of Metso Automation.
h. Jomar International, LTD.
i. Kitz Corporation.
j. Legend Valve.
k. Marwin Valve; a division of Richards Industries.
l. Milwaukee Valve Company.
m. Red-White Valve Corporation.
n. Or Approved equal.
2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig .
c. CWP Rating: 600 psig .
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.

2.3 BRONZE BALL VALVES

A. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
a. Nibco Inc.
b. American Valve, Inc.
c. Conbraco Industries, Inc.; Apollo Valves.

d. Crane Co.; Crane Valve Group; Crane Valves.
e. Hammond Valve.
f. Lance Valves; a division of Advanced Thermal Systems, Inc.
g. Legend Valve.
h. Milwaukee Valve Company.
i. Red-White Valve Corporation.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
k. Or Approved equal.

2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

2.4 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Nibco Inc.
b. American Valve, Inc.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Division.
f. Hammond Valve.
g. Kitz Corporation.
h. Milwaukee Valve Company.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
l. Or Approved equal.

2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Nibco Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.

c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Hammond Valve.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
j. Or Approved equal.

2. Description:
a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.5 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Nibco Inc.
b. American Valve, Inc.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Division.
f. Hammond Valve.
g. Kitz Corporation.
h. Milwaukee Valve Company.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
l. Or Approved equal.
2. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.

B. Class 125, RS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Nibco Inc.
b. American Valve, Inc.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Division.

f. Hammond Valve.
g. Kitz Corporation.
h. Milwaukee Valve Company.
i. Powell Valves.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
k. Or Approved equal.

2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.

2.6 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Nibco Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. Powell Valves.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
j. Or Approved equal.
2. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.

B. Class 125, Bronze Globe Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Nibco Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Red-White Valve Corporation.
e. Or Approved equal.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.

d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.

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.
1. 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 Gate valves.
2. Throttling Service: Globe or ball, valves.
3. Pump-Discharge Check Valves:
a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.
c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

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 except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.

5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass or bronze with brass trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.
4. Bronze Gate Valves: Class 125, NRS.
5. Bronze Globe Valves: Class 125, bronze disc.

3.5 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass or bronze with brass trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.
4. Bronze Gate Valves: Class 125, NRS.
5. Bronze Globe Valves: Class 125, bronze disc.

END OF SECTION 220523

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SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: This section specifies pipe and equipment hangers, brackets, and supports. Pipe supports shall be furnished complete with all necessary inserts, bolts, nuts, rods, washers and other accessories. Piping seismic restraints are specified in Section 22 05 49.

B. Operating Conditions: The hangers and supports specified in this section are provided to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:
   1. Cold Systems: 33°F to 59°F.
   2. Ambient Systems: 60°F to 119°F.
   3. Hot Systems: 105°F to 200°F.

C. Hanger and Support Selection:
   1. In certain locations, pipe supports, anchors, and expansion joints have been indicated on the Drawings, but no attempt has been made to indicate every pipe support, anchor and expansion joint. It shall be the Contractor's responsibility to provide a complete system of pipe supports, to provide expansion joints, and to anchor all piping, in accordance with the requirements set forth herein. Additional pipe supports may be required adjacent to expansion joints, couplings, or valves and shall be provided at no additional cost to the owner.
   2. Concrete or fabricated steel and FRP supports shall be as indicated on the Drawings, as specified in other sections, or, in the absence of such requirements, as permitted by the College's representative.
   3. The Contractor shall select pipe hangers and supports as specified in this Section. Stock hanger and support components shall be used wherever practical. Selections shall be based upon the pipe support classifications specified in this Section.
   4. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.
   5. All piping shall be rigidly supported and anchored so there is no movement or visible sagging between supports.
   6. Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration should be given to the following conditions:
      a. Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.
      b. Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.
      c. Reaction forces due to the operation of safety or relief valves.
      d. Wind loadings on outdoor piping.

7. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, indicated or required, the outside diameter of insulation.
8. Where negligible movement occurs at hanger locations, rod hangers should be used for suspended lines, wherever practical. For piping supported from below, bases, brackets or structural cross members should be used.
9. Hangers for the suspension of size 2-1/2 inches and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.
10. The supporting systems shall provide for and control the free or intended movement of the piping including its movement in relation to that of connected equipment.
11. Where there is horizontal movement at a suspended type hanger location, hanger components shall be selected to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.
12. There shall be no contact between a pipe and hanger or support component of dissimilar metals when supporting copper tubing by use of felt isolator inserts, rubber, plastic or vinyl coated, or felt lined hanger and support components.
13. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.
14. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.
15. Plumber's tape shall not be used to support piping.

1.2 QUALITY ASSURANCE

A. References: This section contains references to the following standards for manufacturer and installation requirements. They are a part of this section in their entirety or as specifically modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail. In case of conflict between the listed documents, the more stringent requirement shall prevail.

AISC 360-10	Manual of Steel Construction - 14th Edition
ASME B31.1	Power Piping
ASME B31.2	Fuel Gas Piping
ASME B31.9	Building Services Piping
ASTM E84	Surface Burning Characteristics of Building Materials, Test Method for
MSS SP58	Pipe Hangers and Supports - Materials, Design and Manufacturer.
MSS SP69	Pipe Hangers and Supports - Selection and Application.
NFPA 13	Installation of Sprinkler Systems.
NFPA 14	Installation of Standpipe and Hose Systems.
SMACNA	Seismic Restraint Manual Guidelines for Mechanical Systems.
UL 203	Pipe Hanger Equipment for Fire Protection Service

B. Supports for Mechanical Systems and Plumbing Piping Systems: In conformance with MSS SP-58 and SP-69.

C. Supports for Sprinkler Piping: In conformance with minimum requirements as established in NFPA 13.

D. Supports for Standpipes: In conformance with minimum requirements as established in NFPA 14.

1.3 SUBMITTALS

A. Submit the following under provisions of paragraph 22 05 00-1.3:
1. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
2. Product Data: Provide manufacturers catalog data including load capacity.
3. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. For every piece of material or equipment with an operating weight of 500 pounds or more, the Contractor shall submit a design support drawing prepared and sealed by a California Licensed Structural Engineer. All designs shall conform to 2013 CBC requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS

A. Standard pipe supports and components shall be manufactured by B-Line, Carpenter & Patterson, Kin-Line, ITT Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, Tolco, Piping Technology & Products, Inc. or equal.

B. Plumbing Piping - DWV:
1. Conform to ASME B31.9, MSS SP58 and MSS SP69.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, and split ring.
3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Carbon steel ring, adjustable, felt lined or vinyl coated.

C. Plumbing Piping - Water:
1. Conform to ASME B31.9, MSS SP58 and MSS SP69.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, and split ring.
3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

9. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
10. Vertical Support: Steel riser clamp.
11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
12. Copper Pipe Support: Carbon steel ring, adjustable, felt lined or vinyl coated.

D. Hydronic Piping:
1. Conform to ASME B31.9, MSS SP58 and MSS SP69.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring, and spring hanger.
3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis, spring hanger.
4. Hangers for Hot Pipe Sizes 2 to 6 Inches: Carbon steel, adjustable, roller, spring hanger.
5. Hangers for Hot Pipe Sizes 6 Inches and Over: Not Used.
6. Pipe Anchor:
   a. Manufacturers:
      1) Piping Technology & Products, Inc.
      2) ITT Grinnell
      3) B-Line
      4) Or equal.
   b. Factory fabricated, double saddle, welded construction, made of high strength carbon steel.
   c. Anchor shall be capable of withstanding a deadweight (downward force) equivalent to the weight 28 feet of Sch.40 pipe filled with water of the pipe size it supports.
   d. Provide with critical dimensions as indicated on the Drawings.
   e. Anchors shall be degreased, and deburred, shop coat primed and ready for welding when delivered to the jobsite.
   f. Pipe anchor shall be capable of withstanding a lateral seismic force equal to 0.6 times the deadweight force. Pipe anchor shall be capable of withstanding an axial thrust load equal to 1/2 of the deadweight force.
7. Pipe Slide Support Assembly:
   a. Manufacturers:
      1) Piping Technology & Products, Inc.
      2) ITT Grinnell
      3) B-Line
      4) Or equal.
   b. Factory fabricated, (2) piece assembly, as indicated on the Drawings.
   c. Top piece shall consist of saddle support with double U-bolt hold down assembly. Assembly shall be completely factory fabricated and have slots for the four (4) hold down bolts of the bottom assembly. Slots shall be sized as follows:
      1) Chilled Water: Provisions for 3/4" slide, either direction along pipe axis.
      2) Refer to the front and side view shown on the drawings.
   d. Assembly shall be capable of withstanding a downward deadweight force equal to the weight of 28 feet of Schedule 40 pipe filled with water of the pipe size it supports. Assembly shall also be capable of withstanding a lateral or tangential seismic horizontal force equal to 0.6 times the deadweight.
8. Pipe Guide Assembly:

a. Manufacturers:
   1) Piping Technology & Products, Inc.
   2) ITT Grinnell
   3) B-Line
   4) Or equal.
b. Factory fabricated, two (2) piece, welded construction, and made entirely of carbon steel.
c. Unit shall consist of retainer outer tube and spider slide/pipe clamp assembly.
d. Assembly shall be capable of withstanding a downward deadweight force equal to the weight of 28 feet of Schedule 40 pipe filled with water of the pipe size it supports. Assembly shall also be capable of withstanding a lateral or tangential seismic horizontal force equal to 0.6 times the deadweight.

9. Elbow Supports:
   a. Welded steel pipe stand with steel base plate anchored and grouted to floor, seismic spring support and welded steel extension off pipe elbow. Use U-bolt cradle where support is below horizontal pipe; refer to the Drawings.
   b. Spring shall have minimum 2" deflection.
10. Wall Support for Pipe Sizes to 4" shall be as indicated on the Drawings.

2.2 STRUCTURAL ATTACHMENTS

A. Steel beam clamp with Eye Nut: Beam clamp and eye nut shall be forged steel. Configuration and components shall comply with MSS and FEDSPEC Type 28. Grinnell Fig. 292, Carpenter & Patterson Fig. 297, or equal.

B. Welded Beam Attachment: Beam attachment shall be carbon steel and comply with MSS and FEDSPEC Type 22. B-Line B3083, Grinnell Fig. 66, or equal.

C. Welded Steel Bracket: Bracket shall be carbon steel and comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket shall comply with MSS Type 33 and FEDSPEC Type 34.

D. Beam "C" Clamp with Locknut and Retaining Strap: Beam clamp and locknut shall be forged steel. Configuration and components shall comply with MSS and FEDSPEC Type 19. Tolco Fig. 65 or 66 with Fig. 69 retaining strap, B-Line B3036 with B3362 strap, or equal.

E. Concrete Wall Attachment: Concrete wall attachments shall conform to SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems.

2.3 ACCESSORIES

A. Hanger Rods: Rods shall be carbon steel or 304 stainless steel, threaded on both ends or continuous threaded and sized as specified.

B. Weldless Eye Nut: Eye nut shall be forged steel and shall comply with MSS and FEDSPEC Type 17. Eye nut shall be Grinnell Fig. 290, B-Line B2300, or equal.

C. Welded Eye Rod: Eye rod shall be carbon steel with eye welded closed. Inside diameter of eye shall accommodate a bolt diameter 1/8 inch larger than the rod diameter. Eye rod shall be Grinnell Fig. 278, B-Line B2311, or equal.

D. Turnbuckle: Turnbuckle shall be forged steel and shall comply with MSS and FEDSPEC Type 15. Turnbuckle shall be Grinnell Fig. 230, B-Line B2311, or equal.

E. Metal Framing Channel: Framing channel shall conform to the Metal Framing Manufacturers Association Standard MFMA-1. Framing channel shall be 1-5/8 inches square, roll formed, and 12–gage carbon steel. Channel shall have a continuous slot along one side with inturned clamping ridges. Framing channel shall be Unistrut P-1000 series, Superstrut A-1200 series, or equal.

F. Vinylester Resin Fiberglass Framing Channel: Framing channel shall conform to ASTM E84 and shall be Class 1 fire-rated. Framing channel shall be 1-5/8" square. All channels shall be supplied with integral notches at 1" on center. Notches shall be located on the interior flange to prevent stoppage of pipe clamps and fittings after installation. Seal exposed glass fibers at cuts with manufacturer's sealant. Framing channel shall be StruTech, Series 200, vinylester resin fiberglass or equal (no known equal).

G. Thermal Pipe Hanger Shield: Thermal shields shall be provided at hanger, support and guide locations on pipe requiring insulation. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. The thermal shield shall be the same thickness as the piping system insulation. The vapor barrier shield shall be used for cold systems. Stainless steel band clamps shall be used where specified to ensure against slippage between the pipe wall and the thermal shield.

2.4 INSERTS:

A. Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

PART 3 - EXECUTION

3.1 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.2 PIPE HANGER AND SUPPORT LOCATIONS

A. The Contractor shall locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc. Locate hangers, supports and accessories within the maximum span lengths specified in the project specifications to support continuous pipeline runs unaffected by concentrated loads.

B. At least one hanger or support shall be located within 2 feet from a pipe change in direction.

C. The Contractor shall locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

D. Where piping is connected to equipment, a valve, piping assembly, etc. that will require removal for maintenance, the piping shall be supported in such a manner that temporary supports shall not be necessary for this procedure.

E. Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

F. Support horizontal cast iron pipe within 18 inches of each joint.

G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor level, not to exceed 8 feet on center spacing.

3.3 INSTALLATION

A. Welded and bolted attachments to the building structural steel shall be provided where required and shall be in accordance with the requirements of SMACNA Seismic Restraint Guide and AISC M016. Unless otherwise specified, there shall be no drilling or burning of holes in the building structural steel.

B. Unless otherwise indicated, attachments to the building concrete shall be in accordance with the requirements of SMACNA Seismic Restraint Guide.

C. Hanger components shall not be used for purposes other than, for which they were designed. They shall not be used for rigging and erection purposes.

D. The Contractor shall install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

E. Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

F. The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

I. Provide felt lined inserts for copper piping.

J. Hanger and support components in contact with plastic or FRP pipe shall be free of burrs and sharp edges.

K. Rollers shall roll freely without binding.

L. Finished floor beneath pipe stand and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of voids and foreign material.

M. Base plates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

N. Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

O. Prime coat all exposed steel hangers and supports. Refer to Section 099100 for painting. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

P. Unless otherwise indicated, exposed exterior steel pipe supports, channel, and clamps shall have hot dipped galvanized finish of minimum 1.50 ounces per square foot on each side in conformance with ASTM A123.

Q. Welds on pipe supports, either interior or exterior shall be cleaned of flux and finished with a "zinc rich" primer.

R. The Contractor shall adjust hangers and supports to obtain required pipe slope and elevation. Shims made of material that is compatible with the piping material may be used. Stanchions shall be adjusted prior to grouting their base plates.

S. Beam clamps shall not be installed on piping greater than 8 inches in diameter. All beam clamps shall have beam clamp retaining straps.

3.4 EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, thickness as indicated on the Drawings and extending 6 inches beyond supported equipment.

B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.5 FLASHING

A. Provide flashing where indicated or necessary.

B. Provide flexible flashing and metal counter flashing where ductwork penetrates weather or waterproofed walls, floors, and roofs.

C. Flash vent and water pipes projecting 12 inches minimum above finished roof surface with lead flashing and cast iron counter flashing, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, seal per Drawing Details.

D. Flash floor drains in floors with topping over finished areas with 6-lb. lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

E. Seal floor drains watertight to adjacent materials.

F. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms installed in accordance with manufacturer's instructions for sound control.

G. Adjust storm collars tight to pipe with bolts; calk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

C. Extend sleeves through floors one inch above finished floor level. Calk sleeves.

D. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and calk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

E. Install chrome plated steel escutcheons at finished surfaces.

3.7 SUPPORT SCHEDULE

PIPE SIZE (Inches)	MAXIMUM SUPPORT SPACING (Feet)	HANGER ROD DIAMETER (Inches)
Steel (Sched. 40)		
1/2	6	3/8
3/4 to 1	8	3/8
1-1/4 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 6	14	5/8
Copper Type L		

1/2 to 3/4	5	3/8
1 to 1-1/4	6	3/8
1-1/2 to 2	8	3/8
2-1/2	9	1/2
3	10	1/2
4 to 6	12	5/8
C.I. No-Hub and at Joints		
1-1/2 to 2	8	3/8
2-1/2 to 3	8	1/2
4 to 6	8	5/8

END OF SECTION 220529

SECTION 220530 - INSULATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: This section specifies insulation for exposed piping and related equipment and appurtenant surfaces.

1.2 QUALITY ASSURANCE

A. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

ASTM B209	Aluminum ad Aluminum-Alloy Sheet and Plate.
ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation.
ASTM D1621	Compressive Properties of Rigid Cellular Plastics.
ASTM D1056	Flexible Cellular Materials.
ASTM C921	Jacketing Materials.
ASTM C533	Mineral Fiber Blanket and Felt Insulation.
ASTM C612	Mineral Fiber Block and Board Insulation.
ASTM C449	Mineral Fiber Hydraulic Setting and Finishing Cement.
ASTM C195	Mineral Fiber Thermal Insulating Cement.
ASTM C547	Mineral Fiber Preformed Pipe Insulation.
ASTM C534	Performed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
ASTM C518	Steady State Heat Flux Measurements.
ASTM C177	Steady State Heat Flux Measurements.
ASTM E84	Surface Burning Characteristics.
ASTM E96	Water Vapor Transmission of Materials.
ASTM D2842	Water Vapor Transmission of Rigid Cellular Plastics.
MICA	National Commercial and Industrial Insulation Standards

B. Applicator: Company specializing in performing the work of this section with minimum three years experience.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

E. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

F. Maintain temperature during and after installation for minimum period of 24 hours.

1.3 SUBMITTALS

A. The following information shall be provided in accordance with the following:
   1. Manufacturer and manufacturer's type designation.
   2. Samples, for each insulation material type, of typical jacket and closures for fittings, valves and appurtenances.
   3. Descriptive literature and catalog data for materials to be used showing methods of installation.

B. Certification of ratings for water vapor transmission and puncture and stiffness.

PART 2 - PRODUCTS

2.1 GENERAL

A. Piping insulation shall be tubular or the flexible blanket type. Insulation for valves, strainers, fittings, expansion joints, flanges and other connections shall be segmented sections, molded, or blanket type coverings of the specified type and thickness of pipe insulation, or the flexible blanket type. Equipment insulation shall be flexible blanket type or rigid board type cut to fit the surface.

2.2 GLASS FIBER

A. Manufacturers: Owens-Corning Fiberglass 25 ASJ/SSL, Certainteed, Knauf or equal.

B. Insulation: ASTM C177; rigid molded, noncombustible.
   1. 'K' value: ASTM C335, 0.23 at 75°F.
   2. Minimum Service Temperature: -20°F.
   3. Maximum Service Temperature: 850°F.
   4. Maximum Moisture Absorption: 0.2 percent by volume.

C. Vapor Barrier Jacket:
   1. ASTM C921, White kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
   3. Secure with self sealing longitudinal laps and butt strips.
   4. Secure with outward clinch expanding staples and vapor barrier mastic.

D. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.

E. Vapor Barrier Lap Adhesive:
   1. Manufacturers: Armstrong, or equal.
   2. Compatible with insulation.

F. Insulating Cement/Mastic:
   1. Manufacturers: Armstrong or equal.
   2. ASTM C195; hydraulic setting on mineral wool.

G. Fibrous Glass Fabric:
1. Cloth: Untreated; 9 oz/sq yd weight.
2. Blanket: 1.0 lb/cu ft density.

H. Indoor Vapor Barrier Finish:
1. Manufacturers: Owens-Corning or equal.
2. Vinyl emulsion type acrylic, compatible with insulation, white color.

I. Outdoor Vapor Barrier Mastic:
1. Manufacturers: Armstrong or equal.
2. Vinyl emulsion type acrylic, compatible with insulation, white color.

J. Insulating Cement:
1. Manufacturers: Armstrong or equal.
2. ASTM C449.

2.3 GLASS FIBER, FLEXIBLE

A. Manufacturers: Owens Corning, Certainteed, Knauf or equal.

B. Insulation: ASTM C553; flexible, noncombustible.
1. 'K' value : ASTM C177, 0.24 at 75°F .
2. Maximum service temperature: 250°F.
3. Maximum moisture absorption: 0.2 percent by volume.
4. Density: 2.0 lb/cu ft density.

C. Vapor Barrier Jacket:
1. ASTM C921, kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

D. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.

E. Vapor Barrier Lap Adhesive:
1. Manufacturers: Armstrong or equal.
2. Compatible with insulation.

F. Insulating Cement/Mastic:
1. Manufacturers: Armstrong or equal.
2. ASTM C195; hydraulic setting on mineral wool.

2.4 GLASS FIBER, RIGID

A. Manufacturers: Owens Corning, Certainteed, Knauf or equal.

B. Insulation: ASTM C612; rigid, noncombustible.
1. 'K' value: ASTM C177, 0.24 at 75°F.
2. Maximum service temperature: 850°F.

3. Maximum moisture absorption: 0.1 percent by volume.
4. Density: 3.0 lb/cu ft density.

C. Vapor Barrier Jacket:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

D. Facing: 1 inch galvanized steel hexagonal wire mesh stitched onto both faces of insulation.

E. Vapor Barrier Lap Adhesive:
1. Manufacturers: Armstrong or equal.
2. Compatible with insulation.

F. Insulating Cement/Mastic:
1. Manufacturers: Armstrong or equal.
2. ASTM C195; hydraulic setting on mineral wool.

2.5 CELLULAR FOAM

A. Manufacturers: Armaflex, Rubatex, or equal.

B. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
1. 'K' value: ASTM C177 or C518; 0.28 at 75 °F.
2. Minimum service temperature: -40 °F.
3. Maximum service temperature: 220 °F.
4. Maximum moisture absorption: ASTM D1056; 3.0 percent (pipe) by volume, 6.0 percent (sheet) by volume.
5. Moisture vapor transmission: ASTM E96; 0.20 perm inches.
6. Maximum flame spread: ASTM E84; 25.
7. Maximum smoke developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive:
1. Manufacturers: Armstrong 520 or equal.
2. Air dried, contact adhesive, compatible with insulation.

2.6 INSERTS

A. Polyurethane Rigid Foam Insulation:
1. Manufacturer: Trymer 9501, Insul Therm or equal.
2. Insulation:
   a. Minimum Service Temperature: -320°F.
   b. Maximum Service Temperature: 300°F.
   c. Moisture Absorption: ASTM D2842, .05 lb/ft2.
   d. "K" value: ASTM C518; 0.14 at 75°F.
   e. Maximum Flame Spread: ASTM E-84; 20.

f. Maximum Smoke Density: ASTM E-84; 50.
g. Compressive Strength: ASTM D-1621; 28 parallel, 20 perpendicular.

B. Hydrous Calcium Silicate:
1. Manufacturer: Pabco Super Caltemp or equal.
2. Insulation: ASTM C533; rigid molded white; asbestos free.
a. "K" value: ASTM C177 and C518; 0.40 at 300°F.
b. Maximum Service Temperature: 1,200°F.
c. Density: 14 lb/cu. ft.

2.7 JACKETS

A. PVC Plastic:
1. Manufacturers for Colored PVC Jackets: Not Used.
2. Manufacturers for White PVC Jackets shall be Proto Corp. LoSMOKE 20, Ceel-Co 550, Foster's Speedline 25/50 or equal.
3. Jacket: ASTM C921, One piece molded type fitting covers and jacketing; high gloss white color unless otherwise indicated.
a. Minimum Service Temperature: 0°F.
b. Maximum Service Temperature: 150°F.
c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
d. Maximum Flame Spread: ASTM E84; 25.
e. Maximum Smoke Developed: ASTM E84; 50.
f. Thickness: 0.020 inch.
g. Connections: Vapor seal mastic.
4. Covering Adhesive Mastic:
a. Manufacturers: Manville Zeston Perma-Weld, Ceel-Co 300 or equal.
b. Compatible with insulation and jacket.

B. Aluminum Jacket: ASTM B209
1. Thickness: 0.020 inch sheet.
2. Finish: Embossed.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: 0.020 inch thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 1/2 inch wide; 0.010 inch thick aluminum.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Insulation shall be applied over clean, dry surfaces. Double layout insulation, where specified or required to achieve the specified surface temperature, shall be provided with staggered section joints.

B. Pipe Supports and Shields: Unless otherwise specified, thermal pipe hanger shields shall be provided by the Contractor and installed during pipe support installation. Where thermal pipe hanger shields are used, apply the following to all butt joints:

1. On cold water, the Contractor shall apply a wet coat of vapor barrier lap cement on all butt joints and seal the joints with a minimum 3 inch wide vapor barrier tape or band.

C. Protection: Insulation and jackets shall be protected from crushing, denting, and similar damage during construction. Vapor barriers, shall not be penetrated or otherwise damaged. Insulation, jacket, and vapor barriers damaged during construction shall be removed and new material shall be installed.

D. Piping Insulation:
1. General:
   a. Pipe: Piping shall be continuously insulated with Glass Fiber specified in paragraph 22 05 30-2.2, along its entire length including in-line devices such as valves, fittings, flanges, couplings, strainers, triple-duty valves and other piping appurtenances. Insulation shall be butted firmly together and jacket laps and joint strips provided with lap adhesive. Jackets shall be provided with their seams located on the topside of pipe for pipes located at least five feet above finished floor. Pipes located below five feet above finished floor shall be provided with their seams located underneath the pipe. Removable flexible blanket-type insulation need not be jacketed. Continue insulation through walls, sleeves, pipe hammers, and other pipe penetrations.
   b. Fittings, Connections, Flanges and Valves: Fitting, connection, flange and valve insulation shall be insulated with Glass Fiber (Flexible or Rigid) specified in paragraph 22 05 30-2.3 and 2.4, provided with jackets specified in paragraph 22 05 30-2.7. Insulation shall be secured in place with 20-gage wire and a coat of insulating cement. Jackets shall be provided with their seams located on the underside of fittings and valves.
2. Insulated Cold Pipes Conveying Fluids Below Ambient Temperatures:
   a. Pipe: Refer to Section 2.5.
   b. Fittings, Connections, Flanges and Valves: Refer to Section 2.5.
3. Insulated Pipes Conveying Fluids Above Ambient Temperature:
   a. Pipe: Provide standard jackets, with or without vapor barrier, factory or field applied. Refer to MICA Plate No. 36.
   b. Fittings, Flanges, and Valves: Insulation shall be covered with PVC jackets specified in paragraph 22 05 30-2.7-A. The ends of jackets shall be secured with PVC end caps (trimmed away from valve stem). Refer to MICA Plate No 12 (fittings) and No. 15 (valves). Covers shall be secured with adhesive.
   c. For hot piping conveying fluids 140°F or less, do not insulate flanges and unions at equipment, but bevel and seal end of insulation.
   d. For hot piping conveying fluids over 140°F, insulate flanges and unions at equipment.
4. Outdoor Piping:
   a. Pipe: Rigid insulation shall be provided with aluminum jackets specified in paragraph 22 05 30-2.7-B unless otherwise indicated. Flexible blanket-type insulation shall be designed for outdoor, weather-exposed service. Refer to MICA Plate No. 6.
   b. Fittings, Connections, Flanges and Valves: Rigid insulation shall be provided with rigid aluminum covers specified in paragraph 22 05 30-2.4-B. Flexible blanket-type insulation shall be designed for outdoor, weather-exposed service. Refer to MICA Plate No. 17 (fittings) and No 14 (valves).
   c. Provide aluminum jacket for all exterior piping.

5. Inserts and Shields:
   a. Inserts for piping conveying fluids below ambient temperature shall be polyurethane as specified in paragraph 22 05 30-2.6-A.
   b. Inserts for piping conveying fluids above ambient temperature shall be polyurethane or calcium silicate as specified in paragraph 22 05 30-2.6.
   c. Application: Piping 2" diameter or larger.
   d. Shields: Minimum 18 gauge galvanized steel between hangers and inserts.
   e. Insert Location: Between support shield and equipment and under the finish jacket.
   f. Insert Configuration: Minimum 6" long, of same thickness and contour as adjoining insulation; may be factory fabricated.
6. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
7. Install insulation for equipment requiring access for maintenance, repair, or cleaning in such a manner that it can be easily removed and replaced without damage.

E. Mechanical Equipment Insulation:
1. General: Unless otherwise specified, insulation shall be Glass Fiber (Flexible and Rigid) specified in paragraph 22 05 30-2.3 and 2.4. Wrap equipment with fiberglass blanket and build box around equipment with 1-1/2" thick fiberglass board. Weld pins or stick clips with washers may be used for flat surfaces and spaced a maximum 18 inches apart. Joints shall be staggered and voids filled with insulating cement. Unless specifically specified to be un-insulated, equipment connected to insulated piping shall be insulated.
2. Low Temperature Class: Insulation shall have joints, breaks, and punctures sealed in facing with fire-retardant vapor barrier adhesive reinforced with 4 inch tape. Insulation shall be provided with a layer of open-weave glass cloth embedded into a wet coat of fire-retardant adhesive. Seams shall overlap at least 2 inches. A finish coat of fire-retardant adhesive shall be provided.

F. Flashing:
1. Flashing shall be provided at jacket penetrations and terminations. Clearance for flashing shall be provided between insulation system and supports.
2. A heavy tack coat of sealant shall be troweled over the insulation, extending over the jacket edge 1 inch and over the pipe of protrusion 2 inches. Reinforcement shall be stretched over the tack coat after clipping to fit over pipe and jacket. Clipped reinforcing shall be strapped with a continuous band of reinforcing to prevent curling. Sealant shall be troweled over the reinforcement to a minimum thickness of 1/8 inch.
3. Aluminum caps shall be formed to fit over the adjacent jacketing and to completely cover coated insulation. Cap shall be held in place with a jacket strap.

3.2 PIPING INSULATION

A. The insulation dimensional tolerances shall comply with the specified standards. Unless otherwise indicated, equipment insulation shall match thickness of attached piping. The minimum insulation thickness exclusive of jacket, and insulation jacket colors shall be as follows:

Service	Piping Service Range°	1" and Less	1.25" to 2"	2.50" to 4"	5" and 6"	8" and Larger	PVC Jacket Color
Domestic Hot Water	105-140	0.5	1.0	1.0	-	-	N/A
Domestic HW Return	100-130	0.5	1.0	1.0	-	-	N/A
Domestic Cold Water	55-75	0.5	0.5	0.5	-	-	N/A
Condensate Drains	50-65	0.5	0.5	0.5	-	-	N/A

3.3 EQUIPMENT INSULATION SCHEDULE

A. Hot Water Heating Systems

Heat Exchangers	1.5 inches
Pumps	1.5 inches
Valves	1.5 inches

END OF SECTION 220530

SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: This section specifies seismic restraints for bracing all piping systems specified in Section 22 05 29.

B. This Section includes the following:
1. Freestanding and restrained spring isolators.
2. Elastomeric isolation pads and mounts.
3. Elastomeric hangers.
4. Spring hangers.
5. Spring hangers with vertical-limit stops.
6. Thrust limits.
7. Pipe riser resilient supports.
8. Resilient pipe guides.
9. Seismic snubbers.
10. Restraining cables.
11. Steel and inertia vibration isolation equipment bases.

1.2 DEFINITIONS

A. A_v: Effective peak velocity related acceleration coefficient.

B. OSHPD: Office of Statewide Health Planning & Development for the State of California. OSHPD assigns a unique anchorage preapproval "R" number to each seismic restraint it tests. The number describes a specific device applied as tested.

C. Longitudinal direction - Parallel to the run.

D. Transverse (lateral) direction - Perpendicular to the run.

1.3 PERFORMANCE REQUIREMENTS

A. A_v: 0.56 Per SEI/ASCE 7-10

B. Component Seismic Coefficient: 3.0. Per SEI/ASCE 7-10

C. Performance Criteria Factor: 1.0. Per SEI/ASCE 7-10

D. Attachment Amplification Factor: 1.0. Per SEI/ASCE 7-10

1.4 DESIGN PARAMETERS

A. Operating Conditions: The seismic restraints specified in this section are provided to resist pipe movements and loads occurring as a result of an earthquake or other seismic event. All piping shall be provided with seismic restraints in accordance with the Seismic Hazard Level of the SMACNA Seismic Restraint Manual and Earthquake Design.

1.5 RESTRAINT SELECTION

A. Unless otherwise specified, the Contractor shall select, locate and provide seismic restraints for piping in accordance with paragraph 23 05 48-1.02-C. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraints to be used at each point. Seismic restraints may be omitted from the following:
   1. Piping in mechanical equipment rooms less than 1-1/4 inch nominal diameter.
   2. All other piping less than 2-1/2 inch nominal diameter.
   3. All piping suspended by individual hangers 12 inches or less in length, as measured from the top of the pipe to the bottom of the support where the hanger is attached.

   Piping systems shall not be braced to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake (i.e. - wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill, etc.). Restraints shall be sized to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation. There shall be no contact between a pipe and restraint component of dissimilar metals. The Contractor shall prevent contact between dissimilar metals when restraining copper tubing by the use of copper-plated, rubber, plastic or vinyl coated, or stainless steel restraint components.

B. Branch lines shall not be used to brace main lines. Seismic bracing shall not be used to limit the expansion and contraction of the piping system.

1.6 SUBMITTALS

A. Product Data: Include load deflection curves for each vibration isolation device.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:

C. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   1. 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.
   2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

3. Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
4. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.

D. Welding certificates.

E. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:

F. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
2. 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."

G. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
1. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.7 CODES AND REFERENCES

A. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

AISC 360-10	Manual of Steel Construction - 14th Edition
ANSI A58.1	Minimum Design Loads for Buildings and Other Structures.
FEDSPEC WW-H-171e	Hangers and Supports, Pipe.
MFMA-1	Metal Framing Standards Publication.
MSS SP-58	Pipe Hangers and Supports - Materials, Design and Manufacturers.
MSS SP-69	Pipe Hangers and Supports - Selection and Application.
SMACNA	Seismic Restraint Manual Guidelines for Mechanical Systems.
ASCE 7-10	Earthquake Design

1.8 QUALITY ASSURANCE

A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to DSA requirements and shall bear anchorage preapproval "R" number, from DSA or another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Testing and calculations must include both shear and tensile loads and 1 test or analysis at 45 degrees to the weakest mode.

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

C. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional structural engineer licensed in the State of California.

1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.10 EXTRA MATERIALS

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

B. Seismic Snubber Units: Furnish replacement neoprene inserts for all snubbers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 SEISMIC BRACING

A. Manufacturers
   1. Carpenter & Patterson,
   2. B-line,
   3. Tolco,

4. Kin-line,
5. ITT Grinnell,
6. Michigan Pipe Hangers
7. Pipe Shields Incorporated,
8. Superstrut,
9. Unistrut
10. Or Approved equal.

B. Pipe Attachments:
1. Clevis Restraint Attachment: Clevis attachment shall be MSS Type 1, Clevis pipe hanger.
2. Roller Restraint Attachment: Roller attachment shall be MSS Type 43, adjustable roller hanger. Hold down strap shall be carbon steel and sized as follows: pipe size 1 inch through 2 inches shall be 1 inch by 1/8 inch thick, pipe sizes 2-1/2 inch through 4 inch shall be 1-1/4 inch by 3/16 inch tick, 6 inch pipe shall be 2 inch by 3/16 inch thick, 8 inch pipe shall be 2-1/2 by 3/16 inch thick, 10 inch through 16 inch pipe shall be 2-1/2 inch by 1/4 inch thick, 20 inch pipe shall be 3 inch by 1/4 inch thick, and 24 inch pipe shall be 3 inch by 3/8 inch thick.
3. U-Bolt Restraint: U-bolt restraint shall be MSS Type 24 as specified in Section 23 05 29.
4. Framing Channel Pipe Strap: Pipe strap shall be carbon steel, with configuration equivalent to MSS Type 26.

C. Trapeze Restraints
1. General: Unless otherwise specified, trapeze members shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.
2. Single Channel Lateral Restraint: Trapeze restraint cross member shall be 1-5/8 inch square carbon steel framing channel, Unistrut P1000, Superstrut A-1200, or equal. Pipe attachments shall be equivalent to those indicated on the plans for single pipe support.

D. Tangential and Longitudinal Structural Attachments: Unless otherwise specified, structural attachments for tangential and longitudinal seismic braces shall conform to SMACNA Seismic Restraint Manual Table 8-1.

E. Accessories:
1. Hanger Rods: Rods shall be carbon steel or 304 stainless steel, threaded on both ends or continuous threaded and sized per SMACNA Seismic Restraint Manual.
2. Framing Channel: Framing channel shall conform to the Metal Framing Manufacturers Association Standard MFMA-1. Framing channel shall be roll formed, with 12-gage of carbon steel as indicated.
3. Rod Coupling: Rod coupling shall be carbon steel, with sight hole in center of coupling body, Grinnell Fig. 135, Superstrut H-119, or equal.

F. Thermal shields shall be provided at seismic restraint locations on pipe requiring insulation. Thermal pipe hanger shields shall be as specified in paragraph 23 05 29-2.03-G. Stainless steel band clamps shall be provided on thermal shields at longitudinal pipe restraint locations.

2.3 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. Or Approved equal.

B. Elastomeric Isolator Pads EIP: 1/4-inch to 5/16-inch thick ribbed or waffled neoprene, 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: Standard neoprene.
   2. Durometer Rating: 40 or 50.
   3. Number of Layers: 2.

C. Elastomeric Mounts EM: Neoprene-in-shear type with steel reinforced top and base. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed. Bolt holes shall be provided in the base and the top shall have a threaded fastener. The mounts shall include leveling bolts that may be rigidly connected to the equipment. Color-code or otherwise identify to indicate capacity range.
   1. Durometer Rating: 40 or 50.

D. Spring Isolators SI: Freestanding, laterally stable, open-spring isolators.

E. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   1. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   2. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
   3. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   4. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber or neoprene isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig.
   5. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators RSI: 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 1/4-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.

G. Elastomeric Hangers EH: Neoprene-in-shear 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.

H. Spring Hangers SH: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

I. 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.
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. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

J. Spring Hangers with Vertical-Limit Stop SHVLS: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

K. 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.
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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
6. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

L. Thrust Limits TL: 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.

M. 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.
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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
6. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

N. Pipe Riser Resilient Support PRRS: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-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.

O. Resilient Pipe Guides RPS: Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-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.

P. Flexible Pipe Connections FPC: Flexible pipe connectors shall be fabricated of Kevlar or nylon cord, fabric, and neoprene. Flexible pipe connections shall result in a flexible and highly compliant connection that can allow longitudinal, transverse, and angular movements and provide micro-vibration isolation. The flexible connections shall be selected and specially fitted, if necessary, to suit the system temperature, pressure, and fluid type. Rods or cables may be used to control extension of the connector if required by the manufacturer, but shall not inhibit movement necessary to provide sufficient vibration isolation. Flexible pipe connections shall be equivalent to Mason Industries' Type SFDEJ twin-sphere connectors, or equal (no known equal).

Q. Flexible Duct Connections FDC: Flexible duct connections shall be supplied in accordance with industry standards. Material width shall be 150 percent of clear dimension in addition to width required for attachment. Flexible duct connections shall result in a loose and highly compliant connection.

R. Flexible Conduit Connections: Flexible conduit shall be formed of one continuous length of electro-galvanized spiral-wound steel strip. Liquid-tight flexible conduit shall be formed of one continuous length of electro-galvanized spiral-wound steel strip, with neoprene gasket.

2.4 SEISMIC-RESTRAINT DEVICES

A. Manufacturers:
1. B-Line Systems, Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corp.
4. Kinetics Noise Control, Inc.
5. Loos & Co., Inc.; Cableware Technology Division.
6. Mason Industries, Inc.
7. TOLCO Incorporated.
8. Unistrut Diversified Products Co.; Wayne Manufacturing Division.
9. Vibration Eliminator Co., Inc.

10. Vibration Isolation Co., Inc.
11. Vibration Mountings & Controls/Korfund.
12. Or Approved equal.

B. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5, with a flat washer face.

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

D. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
1. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5.

E. Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement.

F. Anchor Bolts: Seismic-rated, drill-in, and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E 488M.

2.5 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers:
1. Amber/Booth Company, Inc.
2. California Dynamics Corp.
3. Isolation Technology, Inc.
4. Kinetics Noise Control, Inc.
5. Mason Industries, Inc.
6. Vibration Eliminator Co., Inc.
7. Vibration Isolation Co., Inc.
8. Vibration Mountings & Controls/Korfund.
9. Or Approved equal.

B. Steel Base SB: Factory-fabricated, welded, structural-steel bases and rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Inertia Base IB: Factory-fabricated, welded, structural-steel bases and rails ready for field-applied, cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.6 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

C. Powder coating on springs and housings.
1. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
2. Baked enamel for metal components on isolators for interior use.
3. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 INSTALLATION

A. Thrust restraints shall be provided in accordance with manufacturers recommendations for all horizontal discharge vibration isolated fans and air handlers where the air thrust exceeds 10 percent of the vibration isolated equipment weight. Thrust is calculated in accordance with the following formula:

THRUST(LB) = TOTAL PRESSURE (INCHES W.C.) x 5.3 x AREA (SQ. FT.)

Thrust restraints shall be oriented parallel to the direction of thrust and located symmetrically about the center of thrust. Ducting at thrust restraints shall be designed to withstand thrust loading or an auxiliary structure shall be provided for thrust restraint mounting. Thrust restraint shall not interfere with or restrict free operation of vibration isolation systems.

B. Install seismic snubbers on isolated equipment. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

C. Install restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.

D. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

E. Install resilient bolt isolation washers on equipment anchor bolts.

F. Rod stiffener assemblies shall be used at seismic restraints for hanger rods over 6 inches in length. A minimum of two rod stiffener clamps shall be used on any rod stiffener assembly.

G. Lateral and longitudinal bracing shall be installed between 45 degrees above 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

H. Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of SMACNA Seismic Restraint Guide and AISC M016. There shall be no drilling or burning of holes in the building structural steel without approval of the College's representative.

I. Embedded anchor bolts shall be used instead of concrete inserts for seismic brace installations in areas below water surface or normally subject to submerging.

J. The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Butt joint connections to pipe insulations shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

K. Restraint components in contact with plastic and FRP pipe shall be free of burrs and sharp edges.

L. Roller shall roll freely without binding.

M. Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.3 EQUIPMENT BASES

A. Fill concrete inertia bases, after installing base frame, with 3000-psi concrete; trowel to a smooth finish.

B. Cast-in-place concrete materials and placement requirements are specified in Division 3.

C. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions for seismic codes at Project site.
1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
6. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.4 FIELD QUALITY CONTROL

A. Testing: College will engage a qualified testing agency to perform the following field quality-control testing:

B. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

C. Testing: Perform the following field quality-control testing:

D. Isolator seismic-restraint clearance.
1. Isolator deflection.
2. Snubber minimum clearances.
3. Air-Mounting System Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Air-Mounting System Operational Test: Test the compressed-air leveling system. Remove malfunctioning units, replace with new units, and retest.
5. Test and adjust air-mounting system controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 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 1/4-inch movement during start and stop.

D. Adjust air spring leveling mechanism.

E. Adjust active height of spring isolators.

F. Adjust snubbers according to manufacturer's written recommendations.

G. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

H. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.6 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train College's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 1 Section.

3.8 VIBRATION BALANCE CRITERIA

A. All rotating equipment shall operate at speeds less than 80% of their true critical speed. Unless otherwise required, equipment shall be balanced according to recommendations given in the following sections.

B. Equipment components such as motors, pump rotors, fan wheels, etc. shall be factory balanced, both statically and dynamically, to meet the filed balance requirements described in section below.

C. Following field installation, each fan and pump over 25 HP shall be balanced in accordance with the following maximum rms velocity levels:
1. Fans: 0.15 inch/sec.
2. Pumps: 0.13 inch/sec.

D. Final in-field balance shall be measured with each fan and pump over 25 HP installed on springs specified for unit. Fans shall be loaded with design static pressure. Measurement shall be carried out in vertical and horizontal and axis planes at impeller shaft bearing location when the equipment is mounted on its vibration isolation mounts.

E. If the equipment is inertia base or skid-mounted, the weight of inertia bases or skids (and of any other components mounted on the same inertia base or skid) will reduce the vibration response when equipment is balanced. Therefore, the balance criteria shall be multiplied by the following factor for such equipment.

$$\text{Factor} = \frac{W}{WT+W}$$

Where WT = Inertia weight (base + other components)

W = Weight of the subject equipment

3.9 PIPE ISOLATION

A. Piping connected to vibration isolated equipment should be isolated from the equipment using twin-sphere flexible pipe connectors as described in Paragraph 2.2.M.

B. Piping, 4 inches diameter or greater, which is connected to vibration isolated equipment should be supported, for a distance of 25 feet or 50 pipe diameters, whichever is greater, from the building structure by spring isolators, resilient pipe riser, and resilient penetration sleeves.

C. The spring isolators should be selected for a static deflection, under the actual load, of not less than 1 inch. Unit SI and SH isolators (whichever is applicable to the mounting condition) should be used.

D. Resilient pipe risers and guides should be used to support pipe risers, 6" or greater in diameter and within the limits specified in Paragraph 3.9.B. We recommend Mason Industries' type ADA anchors, or equivalent. The piping should make no direct contact with the gypsum board shaft walls.

E. Pipes within the limits specified in Paragraph 3.9.B that penetrate the building structure should be isolated from the structure by the use of resilient penetration sleeve/seals. A ½-inch clear space should be left all around the penetrating duct or pipe. The clear space should be filled with fiberglass for the full depth of the penetration. Both ends of the clear space should be sealed airtight with a non-hardening resilient sealant.

F. Paragraphs C, D, and E above also apply to piping 2 inches diameter or over suspended below or near noise-sensitive spaces.

G. Piping smaller than 2 inches diameter suspended below or near noise-sensitive spaces should be supported with a resilient element of felt, neoprene, or other suitable material inserted between the pipe and pipe clamp.

3.10 DUCT ISOLATION

A. Flexible canvas or rubber duct connections as described in Paragraph 2.2.N should be used at the intake and discharge of each fan or air handling unit. The duct openings should be squarely aligned prior to installation of the flexible connection, so that the clear length is approximately equal all the way around the perimeter. Minimum metal-to-metal clearance should be 4 inches. Flexible duct connections should not be installed until these provisions are met. The fan unit or adjacent duct section should be able to move 1 inch in any direction without causing metal-to-metal contact or stretching out the flexible connection. There should be a distance of at least 3 duct diameters between the inlet of a vaneaxial fan and a flexible connector.

B. When ducts are suspended below or near a noise-sensitive area, they should be isolated, especially for large ducts with air velocities above 1,500 fpm. or with duct static pressure of 2 inches water gage or higher. The isolators should be Unit FSN (Paragraph 2.2.B) or Unit HS

(Paragraph 2.2.G) (whichever is applicable to the mounting condition). The isolators should be selected for a static deflection, under the actual load, of not less than 1 inch.

C. No vibration isolation will be required for other ducts.

3.11 ELECTRICAL ISOLATION

A. Electrical service connections to all vibration isolated mechanical equipment shall be made with flexible conduit. Conduit shall provide a minimum 360 degree turn and result in a loose and compliant connection.

B. Transformers shall be supported on Type DNP vibration isolation pads or provided with integral internal neoprene vibration mounts. For dry transformers, install the isolation beneath the core; for oil-filled transformers, install the isolation beneath the tank.

END OF SECTION 220548

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SECTION 220550 - PLUMBING NOISE AND VIBRATION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General Provisions, General Conditions and General Requirements of the Contract apply to this Section.

1.2 DESCRIPTION

A. Work Included: Isolation of domestic hot, cold, and waste water lines, circulation pump and water heater.

1.3 GENERAL REQUIREMENTS

A. Codes and Standards
   1. Comply with all applicable codes

B. Submittals
   1. See: PLUMBING, GENERAL

C. Vibration Isolation for Domestic Hot, Cold, and Waste Water Plumbing Lines.
   1. Riser Support: 0.06 inch deflection Type A neoprene pads with load- distribution pads under riser clamps.
   2. Horizontal Piping: Minimum 3/8 inch felt between pipe and clevis hanger.
   3. Miscellaneous Attachments: Trisolators.
   4. Seismic Restraints: Suspended piping - cables as required by code.
   5. Vibration Isolation: Isolate plumbing lines within the vicinity of pumps. Plumbing line isolators shall have a static deflection equal to that of the pump isolation.

D. Vibration Isolation for Water Heater.
   1. 0.06 inch deflection Type A neoprene pads.

E. Vibration Isolation for In-Line Circulation Pumps (suspended).
   2. 1 inch deflection spring hangers, type I.

F. Water Hammer Arrestors
   1. Incorporate a water hammer arrestor on connections to equipment using a quick closing valve.

G. Flexible conduits at connections to motors and other vibrating equipment.

H. Provide suitable flexible piping at connections to vibration isolated equipment such that vibration isolator efficiency is not reduced.

I. Use resilient elements at all support points where permitted. Where permitted, make no rigid connections between equipment, piping, and the building structure which would degrade the noise and vibration isolation system.

J. Where plumbing lines run through double-stud partitions, mount lines only on service-side row of studs.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Type A: Neoprene pad. Waffle, ribbed, or other forms. Typically 1/4 to 5/16 inch thick. Durometers of 40 to 65. Static deflections from 0.01 to 0.07 inches. Nominal design 40 durometer for 0.05 inches static deflection. Provide steel load distribution plates. Size of pad to be specified by isolator supplier based on load per pot. Mason W and WM, Vibrex R, or equivalent.

B. Type I: Spring Hangers. Steel spring with neoprene cap in steel hanger frame. Static deflection range 1.2 to 2.0 inches nominal. Designed to preclude contact of hanger rods with frame (30 degrees misalignment.) Mason 30, Vibrex RMSA, or equivilent.

C. Type P: Trisolators. Sheet metal sleeve with felt insert to be installed at attachment points of hangers or piping. Semco, Elcen, Elmdor/Stoneman or equivalent shop- fabricated device.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Vibration Isolation: According to manufacturer's directions.

B. Seismic Restraint: According to all relevant codes.

C. Flexible electrical connections.
   1. Option 1: The flexible conduit shall be installed in a grossly slack loop form or shallow "U" form. The stranded conductors shall be installed with sufficient slack to accommodate maximum possible movement.

   2. Option 2: The flexible coupling shall be free and not in contact with any nearby building construction and shall be installed slack and free of strain in any direction. Stranded conductors shall be installed as above.

END OF SECTION 220550

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope: This section specifies plumbing identification for equipment and piping systems specified in Division 22. The following are included: nameplates, tags, stencils and pipe markers.

1.2 QUALITY ASSURANCE

A. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

ANSI A13.1	Scheme for the Identification of Piping Systems.
MIL-STD-810C	Environmental Test Methods.

1.3 SUBMITTALS

A. Submit the following under provisions of paragraph 22 05 00-1.3.
1. Submit list of wording, symbols, letter size, and color coding for plumbing identification.
2. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
3. Product Data: Provide manufacturers catalog literature for each product required.

1.4 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 013300 and 017700.

B. Record actual locations of tagged valves on Record Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Seton Name Plate Company, Inc.

B. Marking Services, Inc.

C. WH Brady Company.

D. Or equal

2.2 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved white letters on black background color.

2.3 TAGS

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

B. Chart: Typewritten letter size list in anodized aluminum frame.

2.4 STENCILS

A. Stencils: With clean cut symbols and letters of following size:

3/4 to 1-1/4 inch O.D. of Insulation or Pipe:	8 inch long color field, 1/2 inch high letters.
1-1/2 to 2 inch O.D. of Insulation or Pipe:	8 inch long color field, 3/4 inch high letters.
2-1/2 to 6 inch O.D. of Insulation or Pipe:	12 inch long color field, 1-1/4 inch high letters.
Equipment:	2-1/2 inch high letters.

B. Stencil Paint: Semi- gloss enamel, colors conforming to ANSI A13.1 unless otherwise specified.

2.5 PIPE MARKERS

A. Plastic markers for coding pipe shall conform to ANSI A13.1. Markers shall be the mechanically attached type that are easily removable and firmly attached; they shall not be the adhesive applied type. Markers shall consist of pressure sensitive legends applied to plastic backing which is strapped or otherwise mechanically attached to the pipe. Legend and backing shall be resistant to petroleum based oils and grease and shall meet criteria for humidity, solar radiation, rain, salt, fog and leakage fungus, as specified by MIL-STD-810C. Markers shall withstand a continuous operating temperature range of -40∞F to 180∞F. Plastic coding markers shall not be the individual letter type but shall be manufactured and applied in one continuous length of plastic.

B. Markers bearing the legends on the background colors specified in ANSI A13.1 shall be provided in the following letter heights:

Outside Pipe Diameter*, Inches	Letter Height, Inches
Less than 1-1/2	1/2
1-1/2 through 3	1-1/8

*Outside pipe diameter shall include insulation and jacketing

In addition, pipe markers shall include uni- and bi- directional arrows in the same sizes as the legend. Legends and arrows shall be white on blue or red backgrounds and black on other specified backgrounds.

C. Tracer tape shall be 6 inches wide, colored the same as the background colors as specified in ANSI A13.1, and made of inert plastic material suitable for direct burial. Tape shall be capable of stretching to twice its original length.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Prepare surfaces in accordance with Section 099100 for stencil painting.

3.2 INSTALLATION

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

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Section 099100.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

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

F. Identify plumbing equipment with plastic nameplates. Small devices, such as a control valve, may be identified with tags.

G. Identify control panels and major control components outside panels with plastic nameplates.

H. Identify valves in main and branch piping with tags.

I. Identify piping, concealed or exposed with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION 220553

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SECTION 221116 - DOMESTIC WATER PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes domestic water piping from locations indicated to fixtures and equipment inside the building.

1.2 SUBMITTALS

A. Water Samples: Specified in "Cleaning" Article in Part 3.

B. Field quality-control test reports.

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. 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. Transition Couplings: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 COPPER PIPE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed 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 end. 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.

B. Hard Copper Tube: ASTM B 88, Types L and M, 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 end. 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.

2.3 VALVES

A. Refer to Section 22 05 23 "General Duty Valves for Plumbing Piping" of Specification for plumbing general-duty valves.

B. Refer to Section 22 13 19 "Plumbing Specialties" for balancing and drain valves.

2.4 WATER METERS

A. Displacement-Type Water Meters:
1. Description:
   a. Standard: AWWA C700.
   b. Pressure Rating: 150-psig working pressure.
   c. Body Design: Nutating disc; totalization meter.
   d. Registration: In gallons or cubic feet as required by utility.
   e. Case: Bronze.
   f. End Connections: Threaded.

B. Remote Registration System: Direct-reading type complying with AWWA C706 modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

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

B. Flanges may be used on aboveground piping, unless otherwise indicated.

C. Domestic Water Piping on Service Side of Water Meter inside the Building:
1. NPS 4 to NPS 6: hard copper tube and fittings, Type M, with soldered joints.

D. Under-Building-Slab, Domestic Water Piping on House Side of Water Meter, NPS 4 and Smaller: Hard copper tube and fittings, Type K with soldered joints.

E. Aboveground Domestic Water Piping:
1. NPS 1 and Smaller: Hard copper tube and fittings, Type L, with soldered hard copper tube and fittings joints.
2. NPS 1-1/4 and NPS 1-1/2: Hard copper tube and fittings, Type L, with soldered hard copper tube and fittings joints.

3. NPS 2: Hard copper tube and fittings, Type L, with soldered hard copper tube and fittings.
4. NPS 2-1/2 to NPS 3-1/2: Hard copper tube and fittings, Type L, with soldered hard copper tube and fittings.
5. NPS 4 to NPS 6: hard copper tube and fittings, Type L, with soldered hard copper tube and fittings.

F. Non-potable-Water Piping: Same as for potable water:

3.2 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 or gate valves for piping NPS 2 and smaller. Use cast-iron butterfly or gate 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: Memory-stop balancing valves.
4. Drain Duty: Hose-end drain valves.

3.3 PIPING INSTALLATION

A. Comply with manufacturer's product data, including product technical bulletins, installation instructions, design drawings and installation guide.

B. Refer to Division 33 for site water distribution and service piping.

C. Refer to section of specifications "Basic Mechanical Materials and Methods" for basic piping installation.

D. Extend domestic water service piping to exterior water distribution piping in sizes and locations indicated.

E. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight.

F. Install shutoff valve outside of building in concrete yardbox with cast iron cover at each domestic water service.

G. Install domestic water piping level without pitch and plumb.

H. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.

I. Perform the following steps before operation:
1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.

5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Remove filter cartridges from housings, and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use.

J. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

K. Check plumbing specialties and verify proper settings, adjustments, and operation.
1. Water-Pressure Regulators: Set outlet pressure at 80 psig maximum, unless otherwise indicated.

L. Energize pumps and verify proper operation.

3.4 JOINT CONSTRUCTION

A. 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 VALVE INSTALLATION

A. Install sectional valve close to water main on each branch and riser serving plumbing fixtures or equipment. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

B. Install shutoff valve on each water supply to equipment and on each water supply to plumbing fixtures without supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use gate 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. Refer to Section "Plumbing Specialties" of the specification for calibrated balancing valves.

3.6 HANGER AND SUPPORT INSTALLATION

A. Refer to Section "Hangers and Supports for pipe hanger and support devices. Install the following: 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers

B. Install supports according to section of specifications 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

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.

3.7 CONNECTIONS

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

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

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

D. Connect domestic water piping to 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. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Div. 22 Section "Plumbing Fixtures 22 40 00."
   3. 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 is 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 for final inspection by 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. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced domestic water piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. 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 to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

4. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

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

END OF SECTION 221116

SECTION 221319 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies roof overflow and floor drains, floor sinks, cleanouts, hose bibs, trap primers, water hammer arrestors, and backflow preventers.

1.2 QUALITY ASSURANCE

A. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

ANSI A112.19.1M	Enameled Cast Iron Plumbing Fixtures.
ANSI A112.36.2	Cleanouts.
ANSI/ASSE 1018	Trap Seal Primer Valves (Water Supply Fed.)
ANSI/ASME A112.21.1	Floor Drains/Floor sinks.
ANSI/ASME A112.26.1	Water Hammer Arrestors.
ANSI/AWWA C511	Reduced-Pressure Principle Backflow-Prevention Assembly.
IAPMO PS 31	Backflow Prevention Devices.
PDI WH-201	Water Hammer Arrestors.

B. Perform Work in accordance with Uniform Plumbing Code.

C. Conform to Health Department requirements for installation of backflow prevention devices.

D. Provide certificate of compliance from authority having jurisdiction indicating approval of installation and testing of backflow prevention devices.

1.3 SUBMITTALS

A. Submit the following under provisions of paragraph 22 05 00-1.1:
   1. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
   2. Product Data: Provide component sizes, rough-in requirements, service sizes, materials and finishes.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 22 05 00.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

PART 2 - PRODUCTS

2.1 FLOOR DRAINS

A. Manufacturers shall be J.R. Smith Mfg, Mifab, Josam, Zurn Industries, or equal.

B. FD-1: ANSI A112.21.1; Duco cast iron body, flashing collar, and round, adjustable grate. 2" hubless pipe drain connection.
1. Model: F1100C with trap primer connection as manufactured by Mifab.

2.2 AREA DRAIN / DECK DRAINS

A. Manufacturers shall be J.R. Smith Mfg, Mifab, Josam, Zurn Industries, or equal.

B. AD-1: ANSI A112.21.1; Duco cast iron body, flashing collar, and round, adjustable grate. 2" hubless pipe drain connection.
1. Model: 2120Y as manufactured by JR Smith.

2.3 TRENCH DRAIN

A. Manufacturers shall be J.R. Smith Mfg, Mifab, Josam, Zurn Industries, or equal.

B. TD-1: ANSI A112.21.1; 5.10 inches wide, 3.15 inches deep, 40 inches sections, non-sloped. Complete with membrane drain stainless steel edge rail subframe model 96913 and KLASSIKDRAIN K100 stainless steel decorative grate, Class 'A'. Provide No-Hub outlets, closed end cap fittings and grate hardware as required. Coordinate length of trench with floor plans.
1. Model: "SLABDRAIN" H100-8 channel system as manufactured by ACO Drain.

2.4 FLOOR SINKS

A. Manufacturers shall be Mifab, J.R. Smith Mfg, Josam, Zurn Industries, or approved equal.

B. FS-1: Square cast iron body, enamel coated interior, aluminum dome strainer, stainless steel rim and grate.
1. Model: FS-740 as manufactured by Watts.

2.5 ROOF DRAINS

A. Manufacturers shall be Watts, J.R. Smith Mfg, Mifab, Josam, Zurn Industries, or equal.

B. RD-1: ANSI A112.21.1; Roof drain with cast iron flashing clamp, galvanized metal dome strainer, sump receiver. Provide wall cleanouts at building exterior. Covers shall be painted with custom color to match the metal panel wall system or wall color.
1. Model: RD-100 as manufactured by Watts.

C. OD-1: ANSI A112.21.1; Overflow drain complete with cast iron flashing clamp, galvanized metal dome strainer, sump receiver and 2" high water dam. Provide with downspout nozzle (DS-1) and concrete splash guard where OD outlets terminate to paved areas. Coordinate with landscape drawings.
   1. Model: RD-100-R as manufactured by Watts.

2.6 CLEANOUTS

A. Manufacturers shall be J.R. Smith Mfg, Mifab, Tyler Pipe, Mifab, Josam, Zurn Industries, or equal.

B. Exterior Surfaced Areas (CO): ANSI A112.36.2, Line type with lacquered cast iron body and round epoxy coated gasketed cover.

C. Exterior Unsurfaced Areas (COTG): ANSI A112.36.2, Line type with lacquered cast iron body and round epoxy coated gasketed cover.

D. Interior Finished Floor Areas (FCO): ANSI A112.36.2, Cast nickel bronze, two piece body and adjustable nickel-bronze, round cover with gasket seal and bronze plug.

E. Interior Finished Wall Areas (WCO): ANSI A112.36.2, Counter sunk cleanout brass plug in fitting. Chrome plated bronze deep cover with center screw.

2.7 HOSE BIBBS

A. Manufacturers shall be Acorn Engineering, Mifab, Chicago Faucets, Woodford or equal.

B. HB-1 shall be recessed hose box with wall flange and fabricated from 18 gauge type 304 stainless steel with satin finish exterior. Flange shall be 16 gauge stainless steel and polished to a satin finish. Valve shall be cartridge-operated type with vandal resistant lockshield, removable loose key wheel handle and screwdriver operated stop. Door shall be 16 gauge satin finish with removable hinge cylinder lock and integral vacuum breaker in conformance with ANSI/ASSE 1011. Woodford B24.

C. HB-2 shall be vertical standpipe with rough chrome plated finish, bent nose hose bibb , vandal resistant lockshield , removable loose key wheel handle, screwdriver operated stop and vacuum breaker in conformance with ANSI/ASSE 1011. Woodford RHMC-MS.

D. HB-3 shall be suitable to be used with fox drain, complete with 3/4" copper tube , inverted nose with vacuum breaker hose valve. Cartridge operated type, removable loose key wheel handle and vandal resistant lockshield bonnet. Rough Chrome plated body. Model 24 C as manufactured by Woodford.

2.8 TRAP PRIMERS

A. Manufacturers: Mifab M-500-MI-DU, Precision Plumbing Products, or equal.

B. ANSI/ASSE 1018; brass body, "O" ring seals, adjustable to line pressure and desired delivery amount.

C. Trap Primer Distribution Unit: Mifab Model MI-DU, Precision Plumbing Products or equal (no known equal).

D. TP-1 shall be hardwire operated in a recessed box with stainless steel cover complete with 1/2" copper type "L" Pipe to receptor. Provide Distribution unit as required. Rough-in dimensions: 12"X12"X4" Deep. Coordinate power requirement with the electrical contractor (115V/60Hz/1PH).
Model: Mini-Prime MP8-500 as manufactured by Precision Plumbing Products.

E. TP-2 shall be vacuum breaker type. Provide with WC-1/WC-2 Flush Valve Manufacturer option. Complete with 1/2" copper type "L" pipe to receptor.

F. TP-3 shall be electronic type ten opening manifold, hardwired operated in recessed box with stainless steel cover. Complete with atmospheric vacuum breaker, preset 24 hour clock, 120v solenoid valve and compression fittings: 5/8" compression for 1/2" copper type "L" line to receptor. Rough-in dimensions: 14" x 16" x 4" deep. Coordinate power requirements with electrical contractor (120V/60Hz/1Ph).
Model: Prime Time PT-10 as manufactured by Precision Plumbing Products.

G. TP-4 shall be electronic type four opening manifold, hardwired, operated in surface mount box with NEMA-1 cover plate. Complete with atmospheric vacuum breaker, preset 24 hour clock, 120v solenoid valve and compression fittings: 5/8" compression for 1/2" copper type "l" line to receptor. rough-in dimensions: 14" x 16" x 4" deep. coordinate power requirements with electrical contractor (120v/60hz/1ph).
Model: Prime Time PTS-4 as manufactured by Precision Plumbing Products.

2.9 WATER HAMMER ARRESTORS

A. Manufacturers shall be Mifab, J.R. Smith, Zurn Industries, Josam Co or equal.

B. ANSI A112.26.1M; sized in accordance with PDI WH-201, pre-charged suitable for operation in temperature range -100 to 300 °F and maximum 250 psig working pressure.

C. Model: WHB series as manufactured by Mifab.

2.10 BACKFLOW PREVENTERS

A. Manufacturers shall be Wilkins, Watts, Febco, or approved equal.

B. RPBP-1 to RPBP-6 Reduced pressure principle backflow assembly with heavy duty steel body, fusion-bonded epoxy coated externally and internally. Two independently operating, spring loaded check valves with a hydraulically operated differential pressure relief valve located between the check valves. Internal parts are 300 series stainless steel and removable. Provide UL Listed OS&Y gate valves. Furnish with air gap assembly and direct waste line to catch basin.

1. Provide "Wilkins" Model 975XLSU for RPBP-1 TO RPBP-6. For size see Plumbing Fixture Schedule

2.11 VACUUM RELIEF VALVES

A. Units in compliance with ANSI Z21.22 requirements, automatic cold water closed system, vent sized in accordance with ½ cross-sectional area of inlet piping to tank, Conbraco #37-201-01 ½" NPT, Watts #36 or approved equal.

2.12 EARTHQUAKE VALVE

A. Earthquake valve shall be Pacific Seismic Products model 316.

B. The seismic sensor gas shut off that shall be provided with 3.00 inch standard flanged openings (Gaskets and eight stainless steel 5/8 inch bolts and nuts). The valve shall be fitted with one valves body built from bar stock aluminum (Type 6061) to a T6 condition milled on a CNC machine. To minimize the effects of falling debris damage, no die casting shall be used in the valve body design. The valve design will not become more sensitive if the valve becomes off centered. No springs or levers will be allowed. There will be provided three O-rings made of Buna N compound and four silicone gaskets. The top center of the valve shall incorporate one glass circular leveler. Refer to Section 01700 for warranties. The valve will also be provided with one reset key composed of one steel stud milled to .3125 inches/#18 thread and two black plastic knobs with one ball brass insert. The valve must be installed by a state licensed certified contractor for earthquake valve installation. The valve will be painted with gray enamel with an etched primer baked at 200 degrees F for two hours. The valve shall be provided with four .25 inch FNPT openings to accommodate either a .25 inch plug or two male/female .25 inch all brass gas cocks. One of the gas cocks will accommodate the provided pressure when valve needs to be reset. The valve must carry the State of California Architect Certification, International Association of Plumbing Mechanical Officials Listing, Factory Mutual Approval, and Underwriter Laboratory Listing. The maximum allowable working pressure will be 60 psig and tested to five times pressure rating.

2.13 ACCESS PANELS

A. Manufacturers: J.R. Smith, Mifab, Inryco/Milcor, or equal.

B. Provide access panels in all areas where plumbing equipment and specialties including but not limited to valves, water hammer arrestors, cleanouts, etc. are located in non-accessible location to accommodate access for the maintenance and repair. Refer to the architectural drawings for access panel locations.

C. AP-1: access panel (wall at bathroom areas).
   1. Panel shall be nickel bronze with stainless steel, square frame cover. Size shall be minimum 12" x 12".
   2. Model: #4730-12x12U as manufactured by J.R. Smith.

D. AP-2: Access Panel (Fire Rated Wall).

1. Access panel frame shall be 16 gauge stainless steel and panel shall be 20 gauge stainless steel with 1-1/2 hour fire rating (SFM#3325-135-1). Size shall be minimum 18" x 18".
2. Model: MS as manufactured by Milcor.

E. AP-3 Access Panel (non-rated wall).
1. Access panel frame shall be 16 gauge stainless steel and panel shall be 14 gauge stainless steel. Drywall bead shall be stainless steel. Size shall be minimum 14" x 14".
2. Model: MS as manufactured by Milcor.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with Teflon based thread point compound. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install water hammer arrestors complete with gate valve behind access panels.

E. Install trap primers on all floor drains, floor sinks, trench drains, and industrial receptors. Provide 1/2" ball valve and union at each trap primer installation.

END OF SECTION 221319

SECTION 221619 - DISINFECTION OF POTABLE WATER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the furnishing of all labor and materials for disinfection of the potable water system. Potable water systems are those systems which carry domestic water from the supply main without isolation of the branch by a backflow prevention device. Install all plumbing fittings and valves necessary to perform the disinfection.

B. This section also includes the furnishing of all labor and materials to sample water in system following completion of procedure and provide bacteriological analysis of the water.

1.2 QUALIFICATIONS

A. Disinfection: Disinfection shall be done by a commercial disinfection company approved by the College. Submit to the College's Representative the name of the proposed company for approval.

B. Bacteriological Analysis: Water testing shall be done by a laboratory approved by the State Department of Health Services. Submit for approval the name of the proposed laboratory as well as the proposed number and location of samples.

C. Provide a certificate of completion per Part B attached standard chlorination report which denotes the lines disinfected, the concentration applied and the amount and type of disinfection agent used, and that disinfection is in accordance with AWWA C-601 and State Health Department requirements.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Use an approved chlorine agent, applied in liquid form into the system being disinfected. Chlorine gas or a hypochlorite solution may be used to make up the disinfecting liquid.

PART 3 – EXECUTION

3.1 PRELIMINARY PREPARATION OF THE SYSTEM

A. Provide within 3 feet of the supply main, an injection port for introducing the chlorine solution and a gate valve upstream from the injection port.

B. There shall be no dead-end sections in the system exceeding 3 feet in length. All branches within the system shall lead to an outlet for bleeding and flushing.

C. After final pressure tests, open each fixture or outlet to maximum flow and run until the discharge water is free from particulates.

3.2 CHLORINATION PROCEDURE

A. Notify the College's Representative at least five working days prior to the start date of chlorination per Part A attached chlorination report.

B. Install all fixtures to be served by the potable water system before start of chlorination.

C. Prior to injection, place signs on each fixture being treated, reading "Heavily Chlorinated Water - Do Not Use."

D. Introduce the chlorine into the supply stream at a rate to provide a uniform concentration of chlorine in the entire system. Maintain at least 50 ppm chlorine level at each fixture after a hold period of 24 hours. Do not exceed 150 ppm at any time.

E. Draw the injected chlorine in the system through each outlet and fixture until the specified concentration level is reached. Then close all valves including the service cock and supply valve. Keep the system closed during the 24 hour hold period.

F. The College will require a test for the residual concentration in the system at the end of 24 hours. Release no water from the system until these required samples are taken. A minimum concentration of 50 ppm of chlorine is required at all chosen sampling points.

G. After approval to proceed, flush the system at a relatively high velocity to remove the injected chlorine to a concentration in the system of no more than 0.5 ppm above that in the normal supply.

H. After approval to proceed, secure the entire system for at least three days prior to taking samples for bacteriological analysis.

3.3 SAMPLING AND NOTIFICATION

A. At the completion of the three day hold period, take bacteriological water samples with observation by the College's Representative.

B. Sample bottles must be provided by the approved laboratory. After the samples have been collected, the College's Representative may allow temporary use of the water system pending results of the bacteriological analysis of the samples. The system cannot be used unless such allowance in writing is given.

C. Upon completion of sampling, submit the certificate of completion to the College's Representative for approval.

3.4 ANALYSIS

A. Perform qualitative and quantitative bacterial analysis on the water samples and submit a laboratory report. The report must include the presence of any E. Coli bacteria in a 100 ml sample (this must be negative to be acceptable) and a total plate count of bacteria per cc of the sample (this must be less than 100, or equal to the supply).

3.5 FINAL ACCEPTANCE

A. Upon satisfactory completion of all procedures and receipt of acceptable bacteriological results, written approval of the system will be provided by the College's Representative per Part C attached standard chlorination report. Failure to fully comply with the above procedures will result in a requirement to repeat the procedure until acceptable results are achieved, at no additional cost to the College.

END OF SECTION 221619

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SECTION 221919 - SANITARY WASTE, STORM DRAIN, VENT PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes soil and waste, sanitary drainage, vent and storm drain piping inside the building.

1.2 SUBMITTALS

A. Field quality-control test reports.

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Flexible Transition Couplings for Underground Nonpressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.

B. Transition Couplings for Underground Pressure Piping: AWWA C219 metal, sleeve-type coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

C. Hub-and-Spigot Cast-Iron Pipe and Fittings: ASTM A 74, Service class.
   1. Gaskets: ASTM C 564, rubber.

D. Hubless Cast-Iron Pipe and Fittings: ASTM A 888 or CISPI 301.
   1. Couplings: ASTM C 1277 assembly of metal housing, corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral, center pipe stop for below grade, under slab installation.
      a. Heavy-Duty, Type 304, Stainless-Steel Couplings: ASTM A 666, Type 304, stainless-steel shield; stainless-steel bands; and sleeve.
         1) NPS 1-1/2 to NPS 4: 3-inch-wide shield with 4 bands.
         2) NPS 5 to NPS 10: 4-inch-wide shield with 6 bands.
      b. Heavy-Duty, Cast-Iron Couplings: ASTM A 48, 2-piece, cast-iron housing; stainless-steel bolts and nuts; and sleeve.

c. Compact, Stainless-Steel Couplings: CISPI 310 with ASTM A 167, Type 301, or ASTM A 666, Type 301, stainless-steel corrugated shield; stainless-steel bands; and sleeve for above grade.
   1) NPS 1-1/2 to NPS 4: 2-1/8-inch-wide shield with 2 bands.
   2) NPS 5 and NPS 6: 3-inch-wide shield with 4 bands.
   3) NPS 8 and NPS 10: 4-inch-wide shield with 4 bands.
   4) NPS 12 and NPS 15: 5-1/2-inch-wide shield with 6 bands.

E. Steel Pipe: ASTM A 53, Schedule 40, galvanized. Include ends matching joining method.
   1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53 or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
   2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
   3. Steel-Piping, Expansion Joints: Compound, galvanized steel fitting with telescoping body and slip-pipe section. Include packing rings, packing, limit rods, chrome-plated finish on slip-pipe section, and flanged ends.

F. Hard Copper Tube: ASTM B 88, Types L and M, 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 end.
   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.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

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

B. Aboveground, Soil, Waste, Storm Drain and Vent Piping: Use the following piping materials for each size range:
   1. NPS 1-1/4 and NPS 1-1/2: Steel pipe; cast-iron, threaded drainage fittings; and threaded joints.
   2. NPS 1-1/4 and NPS 1-1/2: Copper DWV tube, copper drainage fittings, and soldered joints.
   3. NPS 1 1/2 to NPS 4: Hubless, cast-iron soil piping.

C. Underground, Soil, Waste, Storm Drain and Vent Piping: Use the following piping materials for each size range:
   1. NPS 1 1/2 to NPS 4: Service class, cast-iron soil piping; gaskets; and gasketed joints.
   2. NPS 1 1/2 to NPS 4: Hubless, cast-iron soil piping.

3.2 PIPING INSTALLATION

A. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

B. Install cleanouts at grade and extend to where building storm drains connect to building storm drain system.

C. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Division 22 Section 22 05 17 “Sleeves and Sleeve Seals For Plumbing Piping.

D. 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."

E. 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.

F. 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.

G. Install soil , waste, storm 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.

H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

I. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

A. Refer to Division 22 Section 22 11 16 "Domestic Water Pipe and Fittings for basic piping joint construction.

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.

3.4 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 22 Section 22 05 29 "Hangers and Supports For Plumbing Piping and Equipment.

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

C. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

D. 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.

E. Install supports for vertical cast-iron soil piping every 15 feet.

3.5 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 Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection.

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction.
   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.

3.7 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 221919

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SECTION 222112 - FUEL GAS PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes fuel gas piping, specialties, and accessories within the building and site distribution.

1.2 PROJECT CONDITIONS

A. Site Gas System Pressure: 5.0 psig

B. Building Gas System Pressure: Primary pressure is 5 psig reduced to secondary pressure of 8 Inch of Water Column.

1.3 SUBMITTALS

A. Product Data:
   1. Polyethylene piping systems. Include associated components.
   2. Specialty valves. Include pressure rating, capacity, settings of selected models.
   3. Service meters. Include pressure rating, capacity, and settings of selected models.
   4. Pressure regulators. Include pressure rating, capacity, and settings of selected models.

B. Shop Drawings: For fuel gas piping. Include plans and attachments to other Work.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. ANSI Standard: Comply with ANSI Z223.1, "National Fuel Gas Code."

1.5 COORDINATION

A. 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPING MATERIALS

A. Polyethylene pipe and fittings: Comply with AGA Plastic pipe manual for gas service and include the following:
   1. Pipe: ASTM D2513
   2. Fittings: ASTM D2683 socket type PE fittings, ASTM D3261 Butt heat fusion PE fittings.

B. Steel Pipe: ASTM A 53; Schedule 40; black.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
   2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
   3. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
   4. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
   5. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
   6. Joint Compound and Tape: Suitable for natural gas.
   7. Steel Flanges and Flanged Fittings: ASME B16.5.
   8. Gasket Material: Thickness, material, and type suitable for natural gas.

C. Transition Fittings: Type, material, and end connections to match piping being joined.

2.3 SPECIALTIES

A. Flexible Connectors: ANSI Z21.24, copper alloy.

B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

2.4 VALVES

A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

B. Valves, NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

C. Appliance Connector Valves: ANSI Z21.15 and IAS listed.

D. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.

E. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating.

F. Plug Valves, NPS 2-1/2 and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating.

G. Earthquake Valves: Listed in IAS Directory as complying with ANSI Z21.70 and UL listed. Include mechanical operator.
   1. Manufacturers:
      a. UL-Listed Earthquake Valves:
         1) Energy Pacific.
         2) Safe T Quake Corp.
         3) Seismic Safety Products, Inc.
         4) Seismic Valve Co., Inc.

2.5 GAS REGULATORS

A. Pressure Regulators: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.
   1. Manufacturers:
      a. Service Pressure Regulators:
         1) American Meter Co.
         2) Equimeter, Inc.
         3) Fisher Controls International, Inc.
   2. Service Pressure Regulators: ANSI Z21.80. Include 100-psig-10-psig minimum inlet pressure rating.

B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Use flanges, unions, transition, and special fittings in applications below, unless otherwise indicated.
   1. NPS 3/4 and NPS 1: Steel pipe, malleable-iron threaded fittings, and threaded joints.
   2. NPS 1-1/4 to NPS 4: Steel pipe, malleable-iron threaded fittings, and threaded joints.
   3. NPS 1-1/4 to NPS 4: Steel pipe, steel welding fittings, and welded joints.
   4. Larger Than NPS 4: Steel pipe, steel welding fittings, and welded joints.

3.2 VALVE APPLICATIONS

A. Appliance Shutoff Valves for Pressure 6"–14" w.c.: Appliance connector valve or gas stop.

B. Piping Line Valves, NPS 2 and Smaller: Gas valve.

C. Piping Line Valves, NPS 2-1/2 and Larger: Plug valve or general-duty valve.

3.3 INSTALLATION

A. Install regulator assemblies aboveground. Include gas valve or plug valve for each assembly.
   1. Install gas valve or plug valve and strainer upstream from each service pressure regulator.
   2. Install service pressure regulators with vent outlet turned down and with corrosion-resistant-metal insect screen.

B. Service Entrance Piping: Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.
   1. Exterior service meter will be provided by gas utility.
   2. Install strainer upstream from each earthquake valve. Refer to Division 22 Section "Plumbing Specialties" for strainers.

C. Concealed Locations:
   1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
   2. In Partitions: Protect tubing from physical damage when installed inside partitions or hollow walls.
   3. In Walls: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in masonry walls, subject to approval of authorities having jurisdiction.
   4. Prohibited Locations: Do not install gas piping in or through circulating air ducts, chimneys or gas vents (flues), ventilating ducts, or elevator shafts.

D. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.
   1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

E. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings and in floor channels, unless indicated to be exposed to view.

F. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

G. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

H. Connect branch piping from top or side of horizontal piping.

I. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

J. Install strainer on inlet of each automatic and electrically operated valve.

K. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

3.4 HANGERS AND SUPPORTS

A. Refer to Division 22 Section 22 05 29 "Hangers and Supports For Plumbing Piping and Equipment".

3.5 CONNECTIONS

A. Install piping adjacent to appliances to allow service and maintenance. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.

3.6 FIELD QUALITY CONTROL

A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging," and requirements of authorities having jurisdiction. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

END OF SECTION 222112

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SECTION 222120 - CAST IRON PIPE AND FITTINGS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope: This section specifies cast iron pipe and fittings as applied to sanitary waste and vent systems and storm drainage systems.

B. Definitions: Terms used within this section and throughout Division 22 are defined as follows:
   1. Soil, Waste and Vent: A pipe or piping system which conveys the discharge of water closets, urinals, or fixture having similar functions, to the building drain or building sewer as defined by the Uniform Plumbing Code, Section 103.
   2. Sanitary Vent: A pipe or piping system installed to provide a flow of air to or from the sanitary waste system or to provide a circulation of air within such system to protect trap seals from siphonage and backpressure.
   3. Storm Drain: A pipe or piping system, which conveys rainwater from buildings, surface runoff from all types of precipitation, groundwater, and subsurface water.

1.2 QUALITY ASSURANCE

A. References: This section contains references to the following standards for manufacturer and installation requirements. They are part of this section in their entirety or as specifically modified. In case of conflict between the requirements of this section and following listed documents, the requirements of this section shall prevail.

AWWA C105/A21.5	Polyethylene Encasement
ANSI/AWWA C500	Gate Valves for Water & Sewage Systems
ASTM A48	Grey Iron Castings.
ASTM A-888	Hubless Cast Iron Soil Pipe & Fittings.
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials.

1.3 SUBMITTALS

A. The following information shall be provided in submittal data information.
   1. Manufacturer's certificates of compliance with the specified standards.
   2. Submittals shall be provided for pipe, pipe fittings, pipe couplings, pipe joint restraints, and polyethylene encasement materials.

PART 2 - PRODUCTS

2.1 HUBLESS CAST IRON SOIL PIPE AND FITTINGS

A. Pipe: ASTM A-888/CISPI 301, gray iron casting with smooth interior walls, uniformly coated with suitable adherent material.

B. Fittings: ASTM A-888/CISPI 301, gray iron castings conforming to properties and dimensions specified.

C. Joints: ASTM A-48, cast iron housing with bituminous material coating; ASTM C564, circular neoprene gasket with diametrically opposed ears, and 18-8 stainless steel nuts & bolts.

2.2 RECTANGULAR CAST IRON PIPE AND FITTINGS

A. Pipe: ASTM A-48, gray cast iron casting, with smooth interior walls, uniformly coated with suitable adherent material.

B. Fittings: ASTM A-48, gray cast iron castings with smooth interior walls uniformly coated with suitable adherent material.

C. Joints:
1. ASTM C564, rubber gaskets manufactured from vulcanized virgin neoprene rubber compound containing no scrap or reclaim products.
2. FS-QQ-C-40(2), Lead and Oakum joints. Either lead wool or lead pig with treated or untreated oakum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Confirm excavations have been completed to comply with Section 312333 requirements.

B. Confirm excavations are to required grade and are not over-excavated.

C. Verify natural soil compaction complies with Section 312333 requirements.

D. Confirm trench walls are properly shored to comply with CAL-OSHA requirements prior to workmen entering the trench.

E. Coordinate with related trades to establish routing and supports for vent manifold.

3.2 PREPARATION

A. Provide sand bedding at trench bottom to comply with Division 1 requirements. Excavate by hand for bell & spigot pipe joints.

B. Repair any piping or utilities damaged during excavation. Insure utility service is fully operational following repairs.

3.3 INSTALLATION

A. Install piping to comply with IAPMO installation standards and Uniform Plumbing Code requirements.

B. Align piping properly in a straight and direct fashion. Maintain uniform gradient throughout drainage systems.

C. Remove dirt and debris inside and outside piping prior to assembly.

D. Provide polyethylene tube encasement for all underground piping to comply with AWWA C105, Method "B" requirements.

E. Prepare piping, supports and accessories not prefinished, ready for finish painting to comply with Section 099100 requirements.

F. Provide seismic bracing and pipe supports within the building as required by the specification.

G. Durham fittings shall be limited in use to trap arm installations above grade.

H. Lead and Oakum joints shall be limited in use to closet rings and rectangular pipe joints.

I. Provide PTFE tape or Teflon based pipe joint compound on male threads of all threaded pipe connections

J. Provide pipe joint restraints for all piping 5" and larger as recommended by CISPI.

K. Connection to exterior waste line within 5' of the service shall be provided with Fernco 5000 series heavy duty couplings.

3.4 APPLICATION

A. Provide additional bracing on sump discharge lines within the building to secure lateral or longitudinal movement.

B. Provide gate valves and backwater valves on sump pump discharge line to comply with UPC, 409 requirements.

C. Provide polyethylene encasement for all cast iron drainage piping below grade. Provide 10-mil polyethylene pipe wrap tape, 2" wide, to secure wrapping.

3.5 SERVICE CONNECTIONS

A. Before commencing work, check invert elevations required for sanitary sewer and storm drainage connections. Conform piping can be installed to maintain a minimum 2% slope throughout the system.

END OF SECTION 222120

SECTION 223400 - DOMESTIC WATER HEATER BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Commercial, direct vent, condensing, gas-fired, storage, domestic-water heaters.
   2. Domestic-water heater accessories.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE.
   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 and size of domestic-water heater indicated.

B. Shop Drawings:
   1. Wiring Diagrams: For power, signal, and control wiring.

C. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.

D. Product certificates.

E. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

F. Source quality-control reports.

G. Field quality-control reports.

H. Operation and maintenance data.

I. Warranty: Sample of special warranty.

J. Commissioning Pre-functional checklist.

1.4 QUALITY ASSURANCE

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

B. ASHRAE/IESNA 90.1 Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:
   1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
   1. Warranty Periods: From date of Substantial Completion.
      a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
         1) Tank: Five years.
         2) Controls and Other Components: Two years.
      b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, direct vent, condensing, Gas-Fired, Storage, Domestic-Water Heaters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. PVI Industries.
      b. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
      c. Bradford White Corporation
      d. Rheem Manufacturing Company
      e. Apollo HydroHeat & Cooling; a division of State Industries.
      f. GSW Water Heating.
      g. Lochinvar Corporation.
      h. State Industries.
   3. Standard: ANSI Z21.10.1/CSA 4.1.
   4. Enclosure Construction: Steel.
      a. Tappings: ASME B1.20.1 pipe thread.

b. Pressure Rating: 150 psig.
c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

5. Factory-Installed Appurtenances:
   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: ASSE 1005.
   d. Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2.
   e. Jacket: Steel with enameled finish.
   f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
   g. Burner: For use with atmospheric, gas-fired, domestic-water heaters and natural-gas fuel.
   h. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
   i. Temperature Control: Adjustable thermostat.
   j. Combination Temperature-and-Pressure Relief Valve: ANSI Z21.22/CSA 4.4-M. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
6. Draft Hood: Low-profile-type draft diverter, complying with ANSI Z21.12.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. AMTROL Inc.
      b. Flexcon Industries.
      c. Honeywell International Inc.
      d. Pentair Pump Group (The); Myers.
      e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
      f. State Industries.
      g. Taco, Inc.
   3. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
   4. Construction:
      a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
      b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      c. Air-Charging Valve: Factory installed.
   5. Capacity and Characteristics:
      a. Working-Pressure Rating: 150 psig.
      b. Capacity Acceptable: 2 gal. minimum.
      c. Air Precharge Pressure: Per schedule on drawing.

6. EWH-1 shall be Insta-Flow Micro with microprocessor. Pre-Set Temperature shall be 120°F to comply with health department. Install per manufacturers instructions and coordinate with electrical for power requirements. Water heater shall be able to provide at least 1.5gpm hot water at 50°F rise. Rough in dimensions: 9-5/8" Length, 6-1/4" Height, 2-3/4" Depth.
   Model: M-40/208 as manufactured by Chromite.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

F. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 5-psig pressure rating as required to match gas supply.

G. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

H. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
   1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
   2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

I. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
   1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
   2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

J. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches (457 mm) above the floor.

L. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 COMMERCIAL, DOMESTIC-WATER HEATER MOUNTING: Install Commercial domestic-water heaters on domestic-water heater mounting bracket.

A. Maintain manufacturer's recommended clearances.
1. Arrange units so controls and devices that require servicing are accessible.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.
4. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

C. Install gas-fired, domestic-water heaters according to NFPA 54.
1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Division 22 Section "Fuel Gas Pipe and Fittings."

D. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Seismic Bracing and Vibration Isolation."

E. 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.

F. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. 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.

G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 Section "Domestic Water Piping Specialties."

H. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

I. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

J. Fill domestic-water heaters with water.

K. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Division 22 Section "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Division 22 Section "Fuel Gas Pipe and Fittings."

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

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

END OF SECTION 223400

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SECTION 224100 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the following plumbing fixtures:
   1. Water Closets
   2. Urinals
   3. Lavatories
   4. Sinks

1.2 QUALITY ASSURANCE

A. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

ANSI A112.19.5-90	Trim for Water-Closet Bowls, Tanks, and Urinals (Dimensional Standards).
ANSI/ASME A112.6.1-88	Supports for Off-the-Floor Plumbing Fixtures for Public Use.
ANSI/ASME A112.18.1-89	Finished and Rough Brass Plumbing Fixture Fittings.
ANSI/ASME A112.19.1-87	Enameled Cast Iron Plumbing Fixtures.
ANSI/ASME A112.19.2-90	Vitreous China Plumbing Fixtures.
ANSI/ARI 1010-84	Drinking-Fountains and Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers.
ANSI/ARI 1020-84	Application and Installation of Drinking Fountains and Drinking Water Coolers.
ANSI/AWWA C561-92	Disinfecting Water Mains.

B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

C. Verify that field measurements are as instructed by the manufacturer.

D. Accessible plumbing fixtures shall comply with all of the requirements of CBC Division 6.

E. Heights and location of all accessible fixtures shall be mounted according to CBC Sections 11B-602 through 11B-612.

F. Fixture controls shall comply with CBC Sections 11B-601.3 for Drinking fountains, 11B-604.6 for water closets, 11B-604.9.5 for children's water closets, 11B-605.4 for urinals, 11B-606.4 for lavatories and sinks, 11B-607.5 for bathtubs, 11B-608.5 for showers, and 11B-611.3 for washing machines and clothes dryers.

G. Accessible sinks shall be 6-1/2" deep maximum. Sinks shall be mounted with the front of the

higher of the rim and counter surface 34" maximum above the finish floor or ground. Depth of sink or lavatories or sinks shall not interfere with knee and toe clearance provided in accordance with CBC Section 11B-306 when a forward approach is required. CBC sections 11B-606.3 and 11B-606.7.

H. Water supply and drain pipes under lavatories and sinks hall be insulated or otherwise configured to protect against contact. These shall be no sharp or abrasive surfaces under lavatories and sinks. CBC Section 11B-606.

I. Plumbing fixtures and accessories provided in a toilet room or bathing room required to comply with CBC Section 11B-213.2 shall comply with CBC Section 11B-213.3

1.3 SUBMITTALS

A. Submit under provisions of paragraph 22 05 00-1.1.

B. Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.4 OPERATION AND MAINTENANCE DATA

A. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

1.5 WARRANTY

A. Provide three year warranty on all fixtures.

PART 2 – PRODUCTS

PLUMBING FIXTURES:

2.1 WATER CLOSET (WC-1) Accessible.

A. Bowl:
1. Manufacturer: Kohler "Kingston" Model #K-4325, 1.28 gallon per flush or approved equal.
2. ANSI/ASME A112.19.2; wall mounted, siphon jet vitreous china closet bowl with +17-1/4" elongated rim, 1-1/2 inch top spud.

B. Flush Valve:
1. Manufacturer: Sloan Royal "Smooth" Model #111-1.28 HWS exposed flush-o-meter or approved equal.
2. ANSI / ASME A112.19.2 and MSV-29193, Exposed diaphragm type, chrome plated closet flush-o-meter with PERMEX™ Synthetic Rubber Diaphragm with Dual Filtered Fixed Bypass.

C. Seat:
1. Manufacturer: Olsonite Model #95SSCT or approved equal
2. Solid White plastic, open front, extended back, self-sustaining hinge, stainless steel bolts, without cover.

D. Support:
1. J.R. Smith Figure Number 0115Y , Mifab or approved equal
2. ANSI/ASME A112.6

2.2 WATER CLOSET (WC-2)

A. Bowl:
1. Manufacturer: Kohler "Kingston" Model #K-4325, 1.28 gallon per flush or approved equal.
2. ANSI/ASME A112.19.2; wall mounted, siphon jet vitreous china closet bowl with elongated rim, 1-1/2 inch top spud.

B. Flush Valve:
3. Manufacturer: Sloan Royal "Smooth" Model #111-1.28 HWS exposed flush-o-meter or approved equal.
4. ANSI / ASME A112.19.2 and MSV-29193, Exposed diaphragm type, chrome plated closet flush-o-meter with PERMEX™ Synthetic Rubber Diaphragm with Dual Filtered Fixed Bypass.

C. Seat:
3. Manufacturer: Olsonite Model #95SSCT or approved equal
4. Solid White plastic, open front, extended back, self-sustaining hinge, stainless steel bolts, without cover.

D. Support:
1. J.R. Smith Figure Number 0115Y, Mifab or approved equal
2. ANSI/ASME A112.6

2.3 URINAL (U-1) Accessible.

A. Fixture:
1. Manufacturer: Kohler "Bardon" Model #K-4991-ET, 0.125 gallon per flush or approved equal.
2. ASME A112.19.2M; vitreous china.

B. Flush Valve:
1. Manufacturer: Sloan Royal Model # 186-01.25 HEU-HWS exposed flush-o-meter or approved equal.
2. ANSI / ASME A112.19.2 and MSV-29193, Exposed diaphragm type, chrome plated closet flush-o-meter with PERMEX™ Synthetic Rubber Diaphragm with Dual Filtered Fixed Bypass.

C. Support:

1. MIFAB MC-31/MC-32 series or approved equal
2. ANSI/ASME A112.6

2.4 URINAL (U-2)

A. Fixture:
1. Manufacturer: Kohler "Bardon" Model #K-4991-ET, 0.125 gallon per flush or approved equal.
2. ASME A112.19.2M; vitreous china.

B. Flush Valve:
1. Manufacturer: Sloan Royal Model # 186-01.25 HEU-HWS exposed flush-o-meter or approved equal.
2. ANSI / ASME A112.19.2 and MSV-29193, Exposed diaphragm type, chrome plated closet flush-o-meter with PERMEX™ Synthetic Rubber Diaphragm with Dual Filtered Fixed Bypass.

C. Support:
1. MIFAB MC-31/MC-32 series or approved equal
2. ANSI/ASME A112.6

2.5 LAVATORY (L-1) Accessible.

A. Basin:
1. Manufacturer: Kohler "Farmington" Model #K-2905 or approved equal.
2. ANSI/ASME A112.19.2; vitreous china, drop-in counter lavatory, with 4" center faucet holes, front overflow and self rimming and faucet ledge.

B. Trim:
1. Manufacturer: Sloan Model #SF-2400-4-BDM Hard-wired, sensor operated electronic faucet or approved equal.
2. Below Deck Thermostatic mixing valve for scald protection. Sloan model or equal.
3. ASME A112.18.1/CSA B125.1; Hand Washing Faucet, 4" Fixed Centers. Vandal Resistant Spray Head. ADA Compliant, Chrome Plated Solid Brass Construction. 4 ¾" Center to Center Integral Cast Brass Spout. 0.35 GPM Vandal Proof Non-Aerating Spray. Auto-Timed Metering Cartridge, Adjustable Run Time from 2 to 15 seconds, opens with push, 0.25 gallon/cycle. Integral inlet shanks with standard ½" NPSM supply inlets and coupling nut for 3/8" or ½" flexible riser.

C. Drain:
1. Manufacturer: McGuire HD 155WC or approved equal.
2. ASME A112.18.1; Cast Brass Heavy Duty Finish Chrome Plated Offset Wheelchair Strainer with polished chrome cast brass elbow, 17 gauge 1 ¼" seamless brass offset tailpiece, heavy rubber basin washer and fiber friction washer.
3. Supplies: McGuire LF2167LK AB 1953 compliant or approved equal.
4. Insulation: Exposed piping: McGuire Model No. PW2125WCPRO or approved equal.

2.6 LAVATORY (L-2)

A. Basin:
   1. Manufacturer: Kohler "Farmington" Model #K-2905 or approved equal.
   2. ANSI/ASME A112.19.2; vitreous china, drop-in counter lavatory, with 4" center faucet holes, front overflow and self rimming and faucet ledge.

B. Trim:
   4. Manufacturer: Sloan Model #SF-2400-4-BDM Hard-wired, sensor operated electronic faucet or approved equal.
   5. Below Deck Thermostatic mixing valve for scald protection. Sloan model or equal.
   6. ASME A112.18.1/CSA B125.1; Hand Washing Faucet, 4" Fixed Centers. Vandal Resistant Spray Head. ADA Compliant, Chrome Plated Solid Brass Construction. 4 ¾" Center to Center Integral Cast Brass Spout. 0.35 GPM Vandal Proof Non-Aerating Spray. Auto-Timed Metering Cartridge, Adjustable Run Time from 2 to 15 seconds, opens with push, 0.25 gallon/cycle. Integral inlet shanks with standard ½" NPSM supply inlets and coupling nut for 3/8" or ½" flexible riser.

C. Drain:
   5. Manufacturer: McGuire HD 155WC or approved equal.
   6. ASME A112.18.1; Cast Brass Heavy Duty Finish Chrome Plated Offset Wheelchair Strainer with polished chrome cast brass elbow, 17 gauge 1 ¼" seamless brass offset tailpiece, heavy rubber basin washer and fiber friction washer.
   7. Supplies: Chicago No. 1017ABCP or approved equal.
   8. Insulation: Exposed piping: McGuire Model No. PPW155WC or approved equal.

2.6 LAVATORY (L-3) Accessible.

A. Basin:
   3. Manufacturer: Kohler "Kingston" Model #K-2005 or approved equal.
   4. ANSI/ASME A112.19.2; vitreous china, wall mounted lavatory, with 4" center faucet holes, front overflow and faucet ledge.

B. Trim:
   7. Manufacturer: Sloan Model #SF-2400-4-BDM Hard-wired, sensor operated electronic faucet or approved equal.
   8. Below Deck Thermostatic mixing valve for scald protection. Sloan model or equal.
   9. ASME A112.18.1/CSA B125.1; Hand Washing Faucet, 4" Fixed Centers. Vandal Resistant Spray Head. ADA Compliant, Chrome Plated Solid Brass Construction. 4 ¾" Center to Center Integral Cast Brass Spout. 0.35 GPM Vandal Proof Non-Aerating Spray. Auto-Timed Metering Cartridge, Adjustable Run Time from 2 to 15 seconds, opens with push, 0.25 gallon/cycle. Integral inlet shanks with standard ½" NPSM supply inlets and coupling nut for 3/8" or ½" flexible riser.

C. Drain:
   9. Manufacturer: McGuire HD 155WC or approved equal.
   10. ASME A112.18.1; Cast Brass Heavy Duty Finish Chrome Plated Offset Wheelchair Strainer with polished chrome cast brass elbow, 17 gauge 1 ¼" seamless brass offset tailpiece, heavy rubber basin washer and fiber friction washer.

11. Supplies: Chicago No. 1017ABCP or approved equal.
12. Insulation: Exposed piping: McGuire Model No. PW155WCor approved equal.

C. Support Carrier:
1. Manufacturer: MIFAB MC-40/MC-41/MC-42 series or approved equal.

2.7 SERVICE SINK (MS-1)

A. Basin
1. Manufacturer: Kohler "Whitby" Mop Sink" Model #K-6710 acid resistant white enameled cast iron, corner floor mounted sink or approved equal.
2. Rim Guard: Kohler Model #K-8940.

B. Trim
1. Drain: American Standard #7721.038 flat grid drain.
2. Faucet: Chicago Faucet # 540-LD897-SCP wall mounted fitting, vacuum breaker spout with pail hook, wall brace and ¾" male hose thread outlet.
3. Mop Holder: Stern Williams T-40 or approved equal.
4. Hose Holder: Stern Williams T-35 or approved equal.
5. Splash Guard Panel: Stern Williams BP-1-28

2.8 SINK (S-1) Accessible.

A. Basin
1. Manufacturer: Elkay Model #LRAD-2022, countertop mounted, single compartment stainless steel 6" deep sink or approved equal.

B. Trim
1. Manufacturer: Chicago Faucet No. 2300-8E34ABCP or approved equal.
2. Strainer: Elkay Basket strainer model #LK35
3. ASME A112.18.1; Chrome plated center set faucet with 3/8" copper inlet. Provide complete with mounting plate. Chicago Faucet 1006 CP angle stops and flexible riser. Cast brass, LA pattern P-trap, chrome plated where exposed with 1-1/2" IPS escutcheon tube and flange.

2.9 SINK (S-2) Accessible.

A. Basin
1. Manufacturer: Elkay Model #LRAD-2022, countertop mounted, single compartment stainless steel 6-1/2" deep sink or approved equal.

B. Trim
1. Manufacturer: Chicago Faucet No. 116.113.AB.1 electronic Faucet Sensor activated, Hard Wired or approved equal. Coordinate with electrical contractor for power requirements.

2. Strainer: Elkay Basket strainer model #LK35
3. ASME A112.18.1; Chrome plated center set faucet with 3/8" copper inlet. Provide complete with mounting plate. Chicago Faucet 1006 CP angle stops and flexible riser. Cast brass, LA pattern P-trap, chrome plated where exposed with 1-1/2" IPS escutcheon tube and flange. All Accessible piping shall be Pre-Wrapped. Provide required Pre-Wrapped kits as needed.

2.10 SINK (S-3) Accessible.

A. Basin
1. Manufacturer: Just sinks Model SL-ADA-2131-16-GR, Single compartment, 16 gaugge armor group type 304 stainless steel, self rimming. 31"x21"x5-1/2" Deep, 4 hole configuration. Coordinate hole location with Eyewash unit (EEQ-1)

B. Trim
1. Manufacturer: Chicago Faucet No. 1100-L9E35-317ABCP or approved equal.
2. Strainer: Just No. J-15-SSF Stainless steel Flat Grid Strainer or approved equal
3. ASME A112.18.1; Chrome plated center set faucet with 3/8" copper inlet. Provide complete with mounting plate. Chicago Faucet 1006 CP angle stops with Chicago 131-CABNF Thermostatic mixing valve and flexible riser. McGuire No. PWV8089NCO Pre-Wrapped P-Trap. All Accessible piping shall be Pre-Wrapped. Provide required Pre-Wrapped kits as needed.

2.11 SINK (KS-1) Accessible.

A. Basin
1. Manufacturer: Elkay Model #LRAD-2022, countertop mounted, single compartment stainless steel 6" deep sink or approved equal.

B. Trim
1. Manufacturer: Chicago Faucet No. 2301-8E34ABCP with sie hand spray or approved equal.
2. Strainer: Elkay Basket strainer model #LK35
3. ASME A112.18.1; Chrome plated center set faucet with 3/8" copper inlet. Provide complete with mounting plate. Chicago Faucet 1006 CP angle stops with Chicago 131-CABNF Thermostatic mixing calceand flexible riser. McGuire No. PWV8089NCO Pre-Wrapped P-Trap. All Accessible piping shall be Pre-Wrapped. Provide required Pre-Wrapped kits as needed.
4. In-Sink-Erator: Badger 5XP Garbage disposer, ¾ H.P., 1725 RPM, 120 V, 1PH, 9.2 Amps, 60 Hz, with wall switch and sink adapter. Coordinate with electrical contractor for power to the garbage disposer.

2.12 Counter Mounted Emergency Eyewash (EEW-1).
1. Guardian model gbf1849 barrier-free deck-mounted eyewash with 90 deg. Swing-down.

Coordinate left/right hand configuration in field. Provide an individual cold water supply tee. Complete with t&s b-1350 angle loose key stop with 1/2" npt female inlet, 1/2" npt male outlet, 2" adjustable flange and connection from stop to eyewash unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install each fixture with a trap, easily removable for servicing and cleaning.

C. Provide stainless steel braided flexible supplies to fixtures with loose key stops, and escutcheons.

D. Install components level and plumb.

E. Install and secure fixtures in place with wall carriers and bolts.

F. Seal fixtures to wall and floor surfaces with sealant as specified in Division 7, color to match fixture.

G. Solidly attach water closets to wall and floor. Provide water supply to handicap water closets on side closest to adjacent wall.

H. Wrap trap and hot water supply to sinks at handicap locations to insulate against burning the individual.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Confirm location and size of fixtures and openings before rough-in and installation.

3.5 ADJUSTING

A. Adjust work under provisions of Division 1.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

A. Clean work under provisions of Division 1.

B. At completion clean plumbing fixtures and equipment.

3.7 PROTECTION OF FINISHED WORK

A. Protect finished Work under provisions of Division 1.

B. Do not permit use of fixtures during construction.

3.8 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfect water system in compliance with ANSI/AWWA C651

END OF SECTION 224100

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SECTION 224700 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 DRINKING FOUNTAINS (DF-1):

A. Drinking Fountains:
   1. Manufacturer: Elkay Model #EZSTL8WS "EZH20" with bottle filler option or Approved equal.
   2. Description: Bi-level, Accessible vandal-resistant wall-mounted drinking fountain.
      a. Material: Stainless steel with ASME 112.19.2M for drinking fountains with backsplash.
      b. Receptor Shape: Rectangular.
      c. Back Panel: Stainless-steel wall plate behind drinking fountain.
      d. Bubblers: Two, with adjustable stream regulator, located on deck.
      e. Control: Push button.
      f. Supply: NPS 3/8 with ball, gate, or globe valve.
      g. Drain: Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2.
      h. Support: Type I, water cooler carrier. Refer to "Fixture Supports" Article.
      i. Electrical: 115V for integral bottle-filler solenoid valve.
      j. Chiller: No chiller required.

1.2 DRINKING FOUNTAINS (DF-2):

A. Drinking Fountains:
   1. Manufacturer: Elkay Model #EZSTL8WS "EZH20" with bottle filler option (Non-Filtered) or Approved equal.
   2. Description: Bi-level, Accessible vandal-resistant wall-mounted drinking fountain.
      a. Material: Stainless steel with ASME 112.19.2M for drinking fountains with backsplash.
      b. Receptor Shape: Rectangular.
      c. Back Panel: Stainless-steel wall plate behind drinking fountain.
      d. Bubblers: Two, with adjustable stream regulator, located on deck.
      e. Control: Push button.
      f. Supply: NPS 3/8 with ball, gate, or globe valve.
      g. Drain: Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2.
      h. Support: Type I, water cooler carrier. Refer to "Fixture Supports" Article.
      i. Electrical: 115V for integral bottle-filler solenoid valve.
      j. Chiller: No chiller required.

1.3 FIXTURE SUPPORTS

A. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bi level, hanger-type carrier with three vertical uprights.
3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

END OF SECTION 224700

SECTION 230000 – GENERAL MECHANICAL REQUIREMENTS

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 SCOPE

A. Basic mechanical requirements specifically applicable to Division 23 and 33 Sections.

B. Work includes but is not necessarily limited to the following:
   1. Labor, materials, services, equipment, and appliances required for completion of tasks as indicated on drawing or in specification or as inherently necessary to prepare spaces and systems for new installations as follows:
      a. Supply air systems including air handling units, variable air volume terminal units, ductwork, ductwork accessories, and diffusers.
      b. General building environmental exhaust air systems ductwork, ductwork accessories and registers.
      c. Building automation control system.
      d. Chilled water piping to air handling units.
      e. Heating hot water system including boilers, pumps, hydronic specialties, piping, piping accessories, and water treatment.
      f. Testing, adjusting and balancing.

1.3 DRAWINGS AND SPECIFICATIONS

A. Drawings accompanying these Specifications show intent of Work to be done. Specifications shall identify quality and grade of installation and where equipment and hardware is not particularly specified, Contractor shall provide submittals for all products and install them per manufacturers' recommendations, and in a first class manner.

B. Examine Drawings and Specifications for elements in connection with this Work; determine existing and new general construction conditions and be familiar with all limitations caused by such conditions.

C. Plans are intended to show general arrangement and extent of Work contemplated. Exact location and arrangement of parts shall be determined after the Owner has reviewed equipment, as Work progresses, to conform in best possible manner with surroundings, and as directed by the Owner's Representative.

D. Contract Documents are in part diagrammatic and intended to show the scope and general arrangement of the Work under this Contract. The Contractor shall follow these drawings in laying out the equipment, piping and ductwork. Drawings are not intended to be scaled for roughing in measurements or to serve as shop drawings. Where job conditions require minor

changes or adjustments in the indicated locations or arrangement of the Work, such changes shall be made without change in the Contract amount.

E. Follow dimensions without regard to scale. Where no figures or notations are given, the Plans shall be followed.

1.4 UTILITIES

A. Location and sizes of electrical, mechanical and plumbing service facilities are shown in accordance with data secured from existing record drawings and site observations. Data shown are offered as an estimating guide without guarantee of accuracy. Check and verify all data given and verify exact location of all utility services pertaining to Work prior to excavation or performing Work.

1.5 APPLICABLE REFERENCE STANDARDS, CODES AND REGULATIONS

A. Meet requirements all state codes having jurisdiction.

B. State of California Code of Regulations:
1. Title 8, Industrial Relations
2. Title 19, State Fire Marshal Regulations
3. 2016 California Building Code (CBC), Title 24, Part 2
4. 2016 California Electrical Code, Title 24, Part 3
5. 2016 California Mechanical Code, Title 24, Part 4
6. 2016 California Plumbing Code, Title 24, Part 5
7. 2016 California Energy Code, Title 24, Part 6
8. 2016 California Fire Code, Title 24, Part 9
9. 2016 California Standards Code, Title 24, Part 12

C. Additional Referenced Standards:

1.	AABC	Associated Air Balance Council
2.	AMCA	Air Moving and Conditioning Association
3.	ARI	Air-Conditioning and Refrigeration Institute
4.	ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
5.	ASME	American Society of Mechanical Engineers
6.	ASTM	American Society for Testing and Materials
7.	NEMA	National Electrical Manufacturer's Association
8.	NFPA	National Fire Protection Association Standards
9.	PDI	Plumbing and Drainage Institute
10.	UL	Underwriters Laboratories

D. Codes and ordinances having jurisdiction over Work are minimum requirements; but, if Contract Documents indicate requirements, which are in excess of those minimum requirements, then requirements of the Contract Documents shall be followed. Should there be any conflicts between Contract Documents or codes or any ordinances having jurisdiction, report these to the Owner's Representative.

E. Obtain permits, and request inspections from authority having jurisdiction.

1.6 PROJECT AND SITE CONDITIONS

A. The arrangement of and connection to equipment shown on the Drawings is based upon information available and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic and some features of the illustrated equipment installations may require revision to meet actual equipment installation requirements. Structural supports, housekeeping pads, piping connections and adjacent equipment may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions or alterations.

B. Examine all Drawings and Specifications to be fully cognizant of all work required under this Division.

C. Examine site related work and surfaces before starting work of any Section.

D. Install Work in locations shown on approved Drawings, unless prevented by Project conditions.

E. Prepare shop drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission from the Owner's Representative before proceeding.

1.7 COOPERATION WITH WORK UNDER OTHER DIVISIONS

A. Cooperate with other trades to facilitate general progress of Work. Allow all other trades every reasonable opportunity for installation of their work.

B. Work under this Division shall follow general building construction closely. Set pipe sleeves and inserts and verify that openings for chases and pipes are provided.

C. Work with other trades in determining exact location of outlets, pipes, and pieces of equipment to avoid interference with lines required to maintain proper installation of Work.

D. Make such progress in the Work to not delay work of other trades.

E. Commissioning
   1. Commissioning requires the participation of Division 23 mechanical contractor to work to ensure that all systems are operating in a manner consistent with the construction documents and the design intent. The general commissioning requirements and coordination are detailed in Division 1 and in section 230800. This Division shall be familiar with all parts of Division 1 and the commissioning plan issued by the Commissioning Authority and shall execute all commissioning responsibilities assigned to them in the Contract Documents
   2. The mechanical contractor is responsible for assisting the commissioning agent throughout the entire commissioning process on the work under their section. The work is not complete until the commissioning agent and the College has signed off on the commissioned system.

1.8 DISCREPANCIES

A. The Contractor shall check all Drawings furnished him immediately upon their receipt and shall promptly notify the Owner's Representative of any discrepancies. Figures marked on Drawings shall in general be followed in preference to scale measurements. Piping and instrumentation diagrams shall in general govern floor plans and sections. Large-scale drawings shall in general govern small-scale drawings.

B. Where requirements between Drawings and Specifications conflict, the more restrictive provisions shall apply.

C. If any part of the Specifications or Drawings appears unclear or contradictory, apply to Owner's Representative for interpretation and decision as early as possible, including during bidding period. Do not proceed with such work without Owner Representatives decision. Beginning work of any Section constitutes acceptance of conditions.

1.9 CHANGES

A. The Contractor shall be responsible to make and obtain approval from the Owner's Representative for all necessary adjustments in piping and equipment layouts as required to accommodate the relocations of equipment and/or devices, which are affected by any approved authorized changes or Product substitutions. All changes shall be clearly indicated on the "Record" drawings.

1.10 SUBMITTALS

A. Refer to Division 01 for additional requirements.

B. Submit all Division 23 shop drawings and product data grouped and referenced by the specification technical section numbers in one complete submittal package.
   1. Individual or partial submittals are not acceptable and will be returned without review.

C. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section. Next to each specification item, indicate the following:
   1. "No Exception Taken".
   2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

D. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.

E. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

F. Note that prior to acceptance of submittals for review, a submittal schedule shall be submitted to the Owner's Representative.

G. Submit all Division 23 shop drawings and product data grouped and referenced by the specification technical section number in one complete submittal package.

H. Shop Drawings:
1. Include installation details of equipment indicating proposed location, layout and arrangement, accessories, piping, and other items that must be shown to assure a coordinated installation.
2. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
3. If equipment is disapproved, revise drawings to show acceptable equipment and resubmit.
4. Whenever more than one (1) manufacturer's product is specified, the first named product is the basis of design used in the Drawings and the use of alternate-named manufacturer's products or substitutes may require modifications to the design.
5. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the Owner's Representative bearing the Owner's Representative stamp of "Reviewed". All corrections or modifications to the equipment as noted on the shop drawings shall be performed and equipment removed from the job site at the request of the Owner's Representative without additional compensation.
6. Manufacturer's Data: For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, performance and characteristic curves if applicable, and catalog cuts.
7. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute (ANSI) or American Water Works Association (AWWA), submit proof of such conformance to the Owner Representative for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the Owner Representative. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.
8. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.
9. Certificates of Compliance or Conformance with the CMC and CEC: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this Contract. Pre-printed certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance or conformance.

1.11 PRODUCT ALTERNATIVES OR SUBSTITUTIONS

A. Refer to General Conditions and Division 01 for requirements.

1.12 OPERATING INSTRUCTIONS

A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel.

1.13 MANUFACTURER'S RECOMMENDATIONS

A. Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

1.14 GUARANTEE

A. Except as may be specified under other sections in the Specifications, guarantee all equipment furnished under the Specifications for a period of two years from date of project acceptance against defective workmanship and material and improper installation. Upon notification of failure, correct deficiency immediately and without cost to the Owner.

B. Standard warranty of manufacturer shall apply for replacement of parts after expiration of the above period. Manufacturer shall furnish replacement parts to the Owner for their service agency as directed.

1.15 PROJECT RECORD DOCUMENTS

A. Refer to Division 01 for additional requirements.

B. Maintain on site, one set of the following record documents; record actual revisions to the Work:
1. Contract Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other Modifications to the Contract.
5. Reviewed shop drawings, product data, and samples.

C. Store Record Documents separate from documents used for construction. Record documents shall be available for review by the Construction Inspector and Engineer at all times.

D. Record information concurrent with construction progress.

E. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:
1. Manufacturer's name and product model and number.

2. Product substitutions or alternates utilized.
3. Changes made by Addenda and Modifications.

F. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
1. Field changes of dimension and detail.
2. Details not on original Contract Drawings.
3. Provide all record documents and shop drawings in electronic format.

G. All changes, deviations and information recorded on the "Project Record Drawings" set during Construction shall be redrafted onto the latest version of AutoCAD.
1. Contractor hand marked or drafted redlined "Project Record Drawings" will not be accepted.

H. Submit completed shop drawings to the Owner prior to completion in AutoCAD format.

1.16 DELIVERY AND STORAGE

A. Refer to Division 01 for additional requirements.

B. Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B P, Appendix I, titled "Equipment Storage and Maintenance during Construction." Replace damaged or defective items with new items.

1.17 EXTRA MATERIALS

A. Unless otherwise specified, spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with a hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly type inventory of spare parts shall be taped to the underside of the cover.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 GENERAL

A. Obtain and pay for all permits and inspections, including any independent testing required to verify standard compliance, and deliver certificates for same to the Owner's Representative.

3.2 WORK RESPONSIBILITIES

A. The drawings indicate diagrammatically the desired locations or arrangement of piping, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference with structural conditions.

B. The Contractor is responsible for the correct placing of Work and the proper location and connection of Work in relation to the work of other trades. Advise appropriate trade as to locations of access panels.

C. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost, providing the change is ordered before the ductwork, piping, etc. and work directly connected to same is installed and no extra materials are required.

D. Where equipment is furnished by others, verify dimensions and the correct locations of this equipment before proceeding with the roughing-in of connections.

E. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any work, carefully check and verify all dimensions, sizes, etc. with the drawings to see that the equipment will fit into the spaces provided without violation of applicable codes.

F. Should any changes to the Work indicated on the Drawings or described in the Specifications be necessary in order to comply with the above requirements, notify the Owner immediately and cease work on all parts of the contract, which are affected until approval for any required modifications to the construction has been obtained from the Owner.

G. Be responsible for any cooperative work, which must be altered due to lack of proper supervision or failure to make proper provisions in time. Such changes shall be under direction of the Owner and shall be made to his satisfaction. Perform all Work with competent and skilled personnel.

H. All work, including aesthetic as well as mechanical aspects of the Work, shall be of the highest quality consistent with the best practices of the trade.

I. Replace or repair, without additional compensation, any Work, which, in the opinion of the Owner, does not comply with these requirements.

3.3 PAINTING

A. Factory Applied:
   1. Mechanical equipment shall have factory-applied painting systems, which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.
   2. Refer to individual sections of this Division for more stringent requirements.

B. Field Applied:
   1. Paint all mechanical equipment as required to touch up, to match finish on other equipment in adjacent spaces or to meet safety criteria.
   2. Paint all exposed, uninsulated mechanical piping, valves, supports, hangers and appurtenances. Provide minimum 5 mils dry film thickness.
   3. Paint ductwork flat black that are visible behind air outlets and inlets.
   4. Paint all exposed and rooftop ductwork, roof mounted mechanical equipment, ductwork supports, hangers and appurtenances.
   5. Paint shall be a high performance polyurethane enamel coating system.
      a. Acceptable paint manufacturers include Ameron, Tnemec or engineer approved equal.
      b. Acceptable primer manufacturers include Ameron Amershield VOC, Tnemec's Series 1075 (1074) Endura-Shield, semi-gloss (gloss) sheen or equal.
      c. Provide minimum 5 mils dry film thickness.

END OF SECTION 230000

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SECTION 230513 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

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

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 104 deg F and at altitude of 3300 feet above sea level.

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

2.3 POLYPHASE MOTORS

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

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

C. Service Factor: 1.15.

D. Rotor: Random-wound, squirrel cage.

E. Bearings: Re-greaseable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating.

G. Insulation: Class F.

H. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors smaller than 15 HP: Manufacturer's standard starting characteristic.

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

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

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

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

   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter/VFD - Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

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

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 HP shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Electrically commutated (ECM)
   2. Permanent-split capacitor.

3. Split phase.
4. Capacitor start, inductor run.
5. Capacitor start, capacitor run.

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

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

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

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

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

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SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Flexible-hose expansion joints.
   2. Alignment guides and anchors.
   3. Pipe loops and swing connections.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For each anchor and alignment guide, 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 swing connections.
   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.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.6 QUALITY ASSURANCE

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

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

C. Flexible-Hose Expansion Joints:

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

   a. Metraflex Company
   b. Flex-Hose Co., Inc.
   c. Unisource Manufacturing, Inc.
   d. Or equal.

2. Flexible hose expansion loops shall impart no thrust loads to system support, anchors or building structure.

3. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.

4. Flexible Corrugated Hose: Type 316 metal inner hoses and braided 304 outer sheaths.
5. Flexible hose expansion loop(s) shall be furnished with a plugged FPT to be used for a drain or air release vent:

Loop Size	FPT Size
1" – 6"	3/8"

6. Flexible hose expansion loops shall have a factory supplied, hanger / support lug located at the bottom of the 180deg return.Flexible Expansion Loop with Stainless Steel Hose

7. Flexible hose expansion loop(s) shall be rated with an operating pressure in accordance with the table below. The operating pressure shall be based on burst pressure with a 4 to 1 safety factor.

Size	Working Pressure at 70° F Single Braid (PSI)	Working Pressure at 70° F Double Braid (PSI)
½"	1100	1525
¾"	792	1267

1"	571	914
1 ¼"	531	850
1 ½"	472	755
2"	500	750
2 ½"	387	600
3"	288	431
4"	232	371
5"	200	245
6"	170	300
8"	212	260
10"	175	220
12"	160	220

8. Flexible Expansion Loop with Bronze Hose

Size	Working Pressure at 70° F Single Braid (PSI)	Working Pressure at 70° F Double Braid (PSI)
½"	566	753
¾"	468	622
1"	334	444
1 ¼"	306	407
1 ½"	297	395
2"	210	279
2 ½"	194	258
3"	166	221
4"	109	175

2.2 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

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

   a. Advanced Thermal Systems, Inc.
   b. Flex-Hose Co., Inc.
   c. Hyspan Precision Products, Inc.
   d. Metraflex Company.
   e. Or equal.

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Stud: Threaded, zinc-coated carbon steel.
    b. Expansion Plug: Zinc-coated steel.
    c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION JOINT INSTALLATION

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

3.2 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than eight pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. 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.

E. Anchor Attachments:
    1. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

    1. Anchor Attachment to Steel Structural Members: Attach by welding.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Bronze ball valves.
   2. High-performance butterfly valves.
   3. Bronze swing check valves.
   4. Iron swing check valves with closure control.

B. Related Sections:
   1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

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

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

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

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

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

D. Valve Actuator Types:
   1. Handwheel: For valves other than quarter-turn types.
   2. Handlever: For quarter-turn valves NPS 6 and smaller.

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. Solder Joint: With sockets according to ASME B16.18.

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

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. Conbraco Industries, Inc.; Apollo Valves.
   b. Milwaukee Valve Company.
   c. NIBCO INC.
   d. Or equal.
2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Full.

2.3 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Bray Controls; a division of Bray International.
   b. Milwaukee Valve Company.
   c. NIBCO INC.
   d. Or equal.
2. Description:
   a. Standard: MSS SP-68.
   b. CWP Rating: 285 psig at 100 deg F.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
   e. Seat: Reinforced PTFE or metal.
   f. Stem: Stainless steel; offset from seat plane.
   g. Disc: Carbon steel.
   h. Service: Bidirectional.

2.4 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Or equal.

2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.5 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. NIBCO INC.
b. Mueller Steam Specialty; a division of SPX Corporation
c. Or equal.
2. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.
i. Closure Control: Factory-installed, exterior lever and spring.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 VALVE INSTALLATION

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

B. Locate valves for easy access 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 check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball or butterfly valves.
   2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
   3. Throttling Service: Ball, or butterfly valves.
   4. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
      b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Ball Valves: Two piece, full port, bronze with bronze trim.
   2. Bronze Swing Check Valves: Class 125 bronze disc.

B. Pipe NPS 2-1/2 and Larger:
   1. High-Performance Butterfly Valves: Class 150, single flange.
   2. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.

3.6 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Ball Valves: Two piece, full port, bronze with bronze trim.
   2. Bronze Swing Check Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
   1. High-Performance Butterfly Valves: Class 150, single flange.
   2. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections:
1. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
2. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 REFERENCES

A. ASME B31.9 Building Services Piping

B. MSS SP58 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application and installation

C. MSS SP-69 Pipe Hangers and Supports – Selection and Application

D. MSS SP-89 Pipe Hangers and Supports – Fabrication and Installation Practices

1.4 DEFINITIONS

A. ASCE: American Society of Civil Engineers

B. ASME: American Society of Mechanical Engineers

C. ASTM: America Society for Testing and Material

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

E. MFMA: Metal Framing Manufacturers Association

F. SEI: Structural Engineering Institute

1.5 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to Standard ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.6 ACTION SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Metal framing systems.
   3. Pipe stands.
   4. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers 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. Detail fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.7 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.8 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 General

A. Hydronic Piping
   1. Conform to ASME B31.9, MSS SP58 and MSS SP69.

2.2 Manufacturers

A. Tolco

B. B-Line

C. Unistrut

D. ITT Grinell

E. Or Approved Equal

2.3 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel stainless steel.

2.4 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.5 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
   2. Standard: MFMA-4.
   3. Channels: Continuous slotted steel channel with inturned lips.
   4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
   6. Metallic Coating: Electroplated zinc, Mill galvanized, In-line, hot galvanized or Mechanically-deposited zinc.

B. Non-MFMA Manufacturer Metal Framing Systems:
   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 Section 016000 "Product Requirements."
   2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
   3. Standard: Comply with MFMA-4.
   4. Channels: Continuous slotted steel channel with inturned lips.
   5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   6. Hanger Rods: Continuous-thread rod, nuts, and washer made of PVC coated carbon steel, hot dipped galvanized carbon steel or stainless steel.

2.6 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers
   1. Pipe Shields Inc.
   2. Pittsburg Corning Foamglas ONE
   3. ITW Insulation Systems TRYMER 2000 XP

B. Cold Piping: Insulation-Insert Material - ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Hot Piping: Insulation-Insert Material - Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

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

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

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

2.7 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.8 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:
   1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   2. Base: Stainless steel.
   3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
   4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:
   1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   2. Bases: One or more; plastic.
   3. Vertical Members: Two or more protective-coated-steel channels.
   4. Horizontal Member: Protective-coated-steel channel.
   5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.9 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.10 MISCELLANEOUS MATERIALS

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

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick 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. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

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

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. 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.

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

K. 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.

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

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:
1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

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

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

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

3.3 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

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

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting" Section 099123 "Interior Painting" and Section 099600 "High Performance Coatings."

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

3.6 HANGER AND SUPPORT SCHEDULE

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

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

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

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

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

F. Copper Pipe or Tubing
   1. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
   2. Or use padded hangers for piping that is subject to scratching.

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

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
   12. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
   13. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
   14. 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.
   15. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

16. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
   4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   6. C-Clamps (MSS Type 23): For structural shapes.
   7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
   8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
   9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
   10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
   11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
   12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
       a. Light (MSS Type 31): 750 lb.
       b. Medium (MSS Type 32): 1500 lb.
       c. Heavy (MSS Type 33): 3000 lb.
   13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
   14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
   15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

L. 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.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
   2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
   4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
   5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
   6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
   7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
   8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
      a. Horizontal (MSS Type 54): Mounted horizontally.
      b. Vertical (MSS Type 55): Mounted vertically.
      c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

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

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

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SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Elastomeric isolation pads.
2. Housed-restrained-spring isolators.
3. Pipe-riser resilient supports.
4. Resilient pipe guides.
5. Elastomeric hangers.
6. Spring hangers.
7. Restraint cables.
8. Seismic-restraint accessories.
9. Mechanical anchor bolts.
10. Adhesive anchor bolts.
11. Restrained isolation roof-curb rails.

B. Related Requirements:
1. Section 220548 "Vibration and Seismic Controls for Plumbing" for devices for plumbing equipment and systems.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning & Development.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.

a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear an agency acceptable to authorities having jurisdiction.
b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

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

C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
1. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic forces required to select vibration isolators and seismic restraints and for designing vibration isolation bases.
a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
3. 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 was examined for excessive stress and that none exists.
4. 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. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
d. 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).

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-spring mounts and restrained-air-spring mounts to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: 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 and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "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 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 unavailable, 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
   1. Site Class as Defined in the IBC: D.
   2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
      a. Component Importance Factor: According to ASCE 7-10, sections 13.1.3, it depends on whether or not the component contains toxic(Ip=1.5) or non-toxic(IP=1.0) materials.
      b. Component Response Modification Factor: 2 or 2.5.
      c. Component Amplification Factor: 2.5.
   3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 1.457g.

4. Design Spectral Response Acceleration at 1.0-Second Period: 0.534g.
5. Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES.
    a. 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 are subjected.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads.
1. Manufacturer and Model No:
    a. Basis of Design
        1) Mason Industries Type SW
    b. Or Approved Equal by:
        1) California Dynamics Corporation
        2) Kinetics Noise Control
        3) Vibrex
2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Waffle pattern.
6. Sandwich-Core Material: Resilient and elastomeric

2.3 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing.
1. Manufacturer and Model No:
    a. Basis of Design
        1) Mason Industries Type SSLFH
    b. Or Approved Equal by:
        1) California Dynamics Corporation
        2) Kinetics Noise Control
        3) Vibrex
2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
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.

2.4 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression.
   1. Manufacturer and Model No:
      a. Basis of Design
         1) Mason Industries Type RW30N
      b. Or Approved Equal by:
         1) California Dynamics Corporation
         2) Kinetics Noise Control
         3) Vibrex
   2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
   9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.5 RESTRAINT CABLES

A. Manufacturer and Model No:
   1. Basis of Design
      a. Mason Industries Type SCBA Assembly, SCR, UC & CCB
   2. Or Approved Equal by:
      a. California Dynamics Corporation
      b. Kinetics Noise Control
      c. Vibrex

B. Restraint Cables: ASTM A 603 galvanized ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.6 SEISMIC-RESTRAINT ACCESSORIES

A. Manufacturer and Model No:
   1. Basis of Design
      a. Mason Industries Type SCR, UC & CCB
   2. Or Approved Equal by:
      a. California Dynamics Corporation
      b. Kinetics Noise Control

c. Vibrex

B. Hanger-Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

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

D. 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.

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

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

2.7 MECHANICAL ANCHOR BOLTS

A. Manufacturer and Model No:
1. Basis of Design
   a. Mason Industries Type SAB/SAS
2. Or Approved Equal by:
   a. California Dynamics Corporation
   b. Kinetics Noise Control
   c. Hilti

B. 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.

2.8 ADHESIVE ANCHOR BOLTS

1. Basis of Design
   a. Mason Industries Type SAA
2. Or Approved Equal by:
   a. California Dynamics Corporation
   b. Kinetics Noise Control
   c. Hilti

B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.9 VIBRATION ISOLATION EQUIPMENT BASES

A. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Manufacturer and Model No:
   a. Basis of Design
      1) Mason Industries Type RND Rails
   b. Or Approved Equal by:
      1) California Dynamics Corporation
      2) Kinetics Noise Control
      3) Vibrex
2. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
   a. Include supports for suction and discharge elbows for pumps.
3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

B. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Manufacturer and Model No:
   a. Basis of Design
      1) Mason Industries Type MSL
   b. Or Approved Equal by:
      1) California Dynamics Corporation
      2) Kinetics Noise Control
      3) Vibrex
2. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.
3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Concrete Inertia Base: Factory-fabricated], welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
1. Manufacturer and Model No:
   a. Basis of Design
      1) Mason Industries Type BMK
   b. Or Approved Equal by:
      1) California Dynamics Corporation
      2) Kinetics Noise Control
      3) Vibrex
2. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.
3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

5. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.10 RESTRAINED SEISMICALLY ISOLATION ROOF-CURB RAILS

A. Manufacturer:
   1. Basis of Design
      a. Mason Industries
   2. Or Approved Equal by:
      a. California Dynamics Corporation
      b. Kinetics Noise Control

B. Vibrex Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic forces.

C. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic forces.

D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an 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 is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

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

D. Equipment Restraints:
   1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
   3. Brace a change of direction longer than 12 feet.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

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

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

J. 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.

K. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test to 90 percent of rated proof load of device.
5. Measure isolator restraint clearance.
6. Measure isolator deflection.
7. Verify snubber minimum clearances.
8. Test and adjust restrained-air-spring isolator controls and safeties.

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

E. Prepare test and inspection reports.

3.6 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.

END OF SECTION 230548

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SECTION 230549 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination variable frequency drives (VFD), rated 600 V and less, for speed control of poly-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

A. Factory-Installed VFD: A VFD installed by motorized-equipment manufacturer as a component of equipment.

B. Field-Installed VFD: A VFD installed at project site. VFDs shipped with motorized-equipment but installed at project site shall be considered Field-Installed VFDs.

C. Legend:
1. BAS: Building Automation System.
2. EMI: Electromagnetic Interface.
3. IGBT: Insulated-Gate Bipolar Transistor.
4. LAN: Local Area Network.
5. LED: Light-Emitting Diode.
6. MCP: Motor-Circuit Protector.
7. NC: Normally Closed.
8. NO: Normally Open.
9. OCPD: Overcurrent Protective Device.
10. PID: Control Action, Proportional Plus Integral Plus Derivative.
11. PWM: Pulse-Width Modulation.
12. TDD: Total Demand (harmonic current) Distortion.
13. THD(V): Total Harmonic Voltage Demand.
14. VFD: Variable Frequency Drive.

1.4 ACTION SUBMITTALS

A. Product Data for each type of VFD
1. For each type and rating of VFD indicated, include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. Shop Drawings
   1. For each VFD indicated, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
   2. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed VFD's type and details.
      b. Factory-installed devices.
      c. Enclosure types and details.
      d. Nameplate legends.
      e. Short-circuit current (withstand) rating of enclosure unit.
      f. Features, characteristics, ratings, and factory settings of each VFD and installed devices.
      g. Specified Modifications.
   3. Schematic and Connection Wiring Diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance data: For VFDs to include in emergency, operation, and maintenance manuals.
   1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
   2. Manufacturer's written instructions for setting field-adjustable overload relays.
   3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
   4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Power Fuses: equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Control Power Fuses: equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Indicating Lights: Two of each type and color installed.
   4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
   5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member Company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: currently certified by NETA to supervise on-site testing.

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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers.

1.9 PROJECT CONDITIONS

A. Environmental/Service Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:
1. Ambient temperature, 32 to 105°F.
2. Ambient Storage Temperature: Not less than minus 4°F and not exceeding 140°F.
3. 0% to 95% relative humidity, non-condensing.
4. Elevation: Not exceeding 3,300 feet without derating.
5. AC line voltage variation, -35% to +30% of nominal.

B. Interruption of Existing Electrical Systems: do not interrupt electrical systems in facilities occupied by the Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify the Owner's Representative no fewer than three weeks in advance of proposed interruption of electrical systems.
2. Indicate method of providing temporary electrical service.
3. Do not proceed with interruption of electrical systems with the Owner's Representative's written permission.
4. Comply with NFPA-70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDS, and adjacent surfaces and other items.

1.10 COORDINATION

A. Coordinate the features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
1. Torque, speed, and horsepower requirements of the load.
2. Ratings and characteristics of supply circuit and required control sequence.
3. Ambient and environmental conditions of installation location.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of start-up.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. ABB

B. Allen-Bradley

C. Yaskawa America

D. Or Approved Equal

2.2 GENERAL

A. VFD's serving mechanical equipment shall be provided from one manufacturer.

B. Furnish complete variable frequency drives as specified herin for the equipment designated as variable speed.
   1. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified.
   2. Include inlet air filters.
   3. VFD enclosure shall be ventilated and have NEMA 3R rating, unless otherwise specified.

C. The VFD shall convert three-phase, 60 Hz utility power to adjustable voltage and frequency, three-phase power for stepless motor speed control from 10% to 100% of the motor's 60 Hz speed. Input voltage shall be as specified on the drawing shedules.

D. The VFD shall include a converter and an inverter section. The converter section shall convert fixed frequency and voltage AC utility power to DC voltage. The inverter section of the VFD shall invert the DC voltage into a quality output waveform, with adjustable voltage and frequency for stepless motor speed control. The VFD shall maintain a constant V/Hz ratio

E. The VFD and options shall be tested to ANSI/UL Standard 508. The complete drive, including all specified options, shall be UL or ETL listed.

F. Power line noise shall be limited to a voltage distortion factor and line notch depth as defined in IEEE Standard 519-1981, Guide for Harmonic Control and Reactive Compensation of Static Power for Converters. The total voltage distortion shall not exceed 5%.

G. PWM type drives shall include EMI/RFI filters that meet EN61800-3 for First Environment restricted level.

H. Motor noise as a result of the VFD shall be limited to three dB across the line operation, measured at three feet from the motor's center line.

I. The VFD's full load amp rating shall meet or exceed NEC Table 430-150.

J. Protective Features:
   1. Individual motor overload protection for each motor controlled.

2. Protection against input power undervoltage, overvoltage, and phase loss.
3. Protection against output current overload and instantaneous over current.
4. Protection against exceeding temperature limits within VFD enclosure.
5. Protection against overvoltage on the DC bus.
6. Protect VFD from sustained power or phase loss. Undervoltage trip activates automatically when line voltage drops more than 10% below rated input voltage.
7. Automatically reset faults due to undervoltage, overvoltage, phase loss, or exceeding temperature limits.
8. Protection against output short circuit and motor winding shorting to case faults, as defined by UL 508.
9. Status lights or digital display for indication of individual fault conditions.
10. Controller capable of operating without a motor or any other equipment connected to the drive output to facilitate start-up and troubleshooting.
11. The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC buss to minimize power line harmonics and protect the VFD from power line transients.
    a. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire range are not acceptable.
    b. VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

K. Interface Features
1. Door mounted Hand/Off/Auto selector switch to start and stop the VFD. In the AUTO position, the VFD will start/stop from a remote contact closure. In the HAND position, the VFD will run regardless of the remote contact position.
2. Manual speed control capability.
3. Local selector switch: Motor speed is determined by the manual speed control.
4. Power/On light to indicate that the VFD is receiving utility power.
5. Fault light to indicate that the VFD has tripped on a fault condition.
6. Digital meter with selector switch to indicate percent speed and percent load.
7. A set of form-C, dry contacts to indicate when the VFD is in the run mode.
8. A set of form-C, dry contacts to indicate when the VFD is in the fault mode.
9. A 0-10VDC or 4020 mA output signal to vary in direct proportion to the controller's speed.
10. VFD to have terminal strip to accept N.C. safety contacts. VFD to safety shut down in drive or by-pass mode when contacts open.
11. VFD to accept an additional N.C. contact to interface with the Hand/Off/Auto switch for remote Stop/Start control.
12. VFD shall accept an external 0-10 VDC or 4-20 mA speed control signal.
13. VFD shall have Proportional Integral Derivative (PID) loop control for VFD operation and independent PID loop control for Owner use.

L. Adjustments
1. Maximum speed, adjustable 50-100% base speed.
2. Minimum speed, adjustable 0-50% base speed.
3. Acceleration time, adjustable 3-60 seconds.
4. Deceleration times, adjustable 3-60 seconds with override circuit to prevent nuisance trips if deceleration time is set too short.
5. Current limit, adjustable 0-105%.
6. Overload trip set point.

7. Offset and gain to condition the input speed signal.

M. Special Features
1. The following special features shall be included in the VFD enclosure:
   a. VFD shall include a communication port with standard protocols (LONG/BACnet/Modbus) to match Owner DDC system. Coordinate with DDC manufacturer to provide a seamless interface between the VFD and DDC system.
   b. All panels shall be marked for 100,000 AMP short circuit current rating in compliance with UL.
   c. Provide a manual door interlocked main fused disconnect switch, pad lockable in the off position.
2. All power and low voltage terminations into and out of VFD shall be through the bottom of drive cabinet through factory provided knock-outs.
3. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 seconds while starting. The VFD shall provide full motor torque at any selected frequency from 20 Hz to based speed while providing a variable torque V/Hz output at reduced speed. Breakaway torque of 160% shall be available.
4. The VFD shall include current sensors on all output phases.
5. The VFD shall continue to operate with reduced output without faulting with input voltage as low as 70% of the nominal voltage and shall provide full rated output for input voltages of 90% of nominal.
6. The VFD shall have a minimum of Class 20 I2t motor overload protection, which shall automatically compensate for changes in motor speed.
7. All VFDs shall have the same interchangeable customer interface keypad to allow a single programmable keypad to download information to multiple VFDs during startup procedures.
8. The VFD shall accept up to 3 feedback signals, each with independent scaling.
9. None of the above features shall affect the UL listing of the unit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide factory mounting brackets and attachments for VFDs. Field modification or drilling of enclosures is not permitted. Mounting brackets and supports shall not block required access and clearances for VFD.

3.2 START-UP AND COMMISSIONING SERVICE

A. The manufacturer shall provide start-up commissioning of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer's site. Sales personnel and other agents who are not factory certified technicians for drive field repairs shall not be acceptable as commissioning agents.

B. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Included in this service shall be (as a minimum):
   1. Verification of contractor wire terminations to the VFD and its optional circuitry.
   2. Installation verification for proper operation and reliability of the VFD, the motor being drive, and the building automation system.
   3. Conform to training requirements specified elsewhere. In addition, the VFD manufacturer's certified trainer shall provide up to one-hour of customer operator training on operation and service diagnostics at the time of the equipment commissioning.
   4. Measurements for verification of proper operation on each of the following items:
      a. Motor voltage and frequency. Verification of proper motor operation.
      b. Control input for proper building automation system interface and control calibration.
      c. Calibration check for the following setpoints (and adjustments as necessary):
         1) minimum speed
         2) maximum speed
         3) acceleration rate
         4) deceleration rate
      d. VFD manufacturer technician shall document all default and custom drive settings.
   5. Submit Start-Up and Commissioning Reports.

3.3 EXAMINATION

A. Manufacturer/Supplier to verify that jobsite meets factory recommended and code required conditions for proper VFD installation prior to the installation. Additionally, manufacturer/supplier shall make needed recommendations to assure proper installation prior to the installation. Manufacturer/Supplier shall visit jobsite subsequent to the installation to verity VFD's are installed properly. Items considered shall include (at a minimum):
   1. Clearance spacing
   2. Temperature, contamination, dust, and moisture of the environment.
   3. Separate conduit installation of the motor wiring, power wiring, and control wiring.
   4. Installation per the manufacturer's recommendation.
   5. Measure voltage rise, time, and magnitude.
   6. Cover and protect the VFD from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.
   7. VFD input and output power shall be installed in separate conduits.

END OF SECTION 230549

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SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
1. "No Exception Taken".
2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

C. Samples: For color, letter style, and graphic representation required for each identification material and device.

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

E. Valve numbering scheme. See paragraph 2.7.B.

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

1.4 COORDINATION

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

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

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

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers:
1. Craftmark Identification Systems
2. Seton Identification Products
3. MSI Marking Services
4. Setmark
5. Or equal

2.2 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Material and Thickness: Brass or anodized aluminum, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label and substrate.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch 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.

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Color Coding:
1. Background Color: Yellow.

2. Letter Color: Black.

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

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

E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless-steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PIPE LABELS

A. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.

B. General Requirements for Manufactured Pipe Labels: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger pipe sizes may have maximum sheet size with separate fastener.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing. Either marker shall show accepted color-coded background, proper color of legend in relation to background color, accepted legend letter size, accepted marker length.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.5 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

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

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

D. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2

inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

E. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

F. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.6 STENCILS

A. Stencils for Piping: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of ¾ inch for access panel and door labels, equipment labels and similar operational instructions.
1. Stencil Material: Brass
2. Stencil Paint: Exterior, gloss, alkyd enamel, black unless otherwise indicated. Pain may be in pressurized spray-can form.
3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

B. Stencils for Ducts:
1. Lettering Size: Minimum letter height of 1-1/4 inches for viewing distances up to 15 feet and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Brass.
3. Stencil Paint: Exterior, gloss, acrylic enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form.

C. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:
1. Lettering Size: Minimum letter height of 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Brass
3. Stencil Paint: Exterior, gloss, acrylic enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form.

2.7 VALVE TAGS

A. Valve Tags: Stamped or engraved with ¼-inch letters for piping system abbreviation and ½ inch sequenced numbers.
1. Tag Material: Brass, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2 by 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed or modulating), and variations for

identification. Mark valves for emergency shutoff and similar special uses.

1. Valve tag schedule shall be included in operation and maintenance data.

2.8 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER", "CAUTION" or "DO NOT OPERATE."
   4. Color:
      a. Background Color: Yellow.
      b. Letter Color: Black.

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 GENERAL INSTALLATION REQUIREMENTS

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

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

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

3.3 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Section 099123 "Interior Painting"

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. Within one foot of each valve and control device.

2. Near each branch connection and riser takeoff.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. Near major equipment items and other points of origination and termination.
5. At access doors, manholes, and similar access points that permit view of concealed piping.
6. Spaced at maximum intervals of 50 feet along each run, but not less than once in each room at entrance and exit of each concealed space. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings.

C. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe Label Color Schedule:
1. Chilled-Water Piping:
   a. Background Color: Green.
   b. Letter Color: White.
2. Heating Water Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black.
3. Refrigerant Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black.

3.5 DUCT LABEL INSTALLATION

A. Locate ductwork labels where ductwork is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Within one foot of each control device.
2. Near each branch connection and riser takeoff.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. Near major equipment items and other points of origination and termination.
5. Spaced at maximum intervals of 20 feet along each run, but not less than once in each room at entrance and exit of each concealed space.
6. On ductwork above removable acoustical ceilings.

B. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
1. Exhaust Air Ducts:
   a. Background Color: Yellow.
   b. Letter Color: Black.
2. Supply Air, Return Air and Outside Air:
   a. Background Color: Blue.

b. Letter Color: White

3. Return Air and Outside Air:
   a. Background Color: Green.
   b. Letter Color: White

3.6 VALVE-TAG INSTALLATION

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

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
      a. Chilled Water: 2 inches, round.
      b. Hot Water: 2 inches, round.
      c. Refrigerant: 2 inches, round.
      d. Gas: 2 inches, round.
   2. Valve-Tag Color:
      a. Chilled Water: Natural.
      b. Hot Water: Natural.
      c. Refrigerant: Natural.
      d. Gas: Natural.
   3. Letter Color:
      a. Chilled Water: Black.
      b. Hot Water: Black.
      c. Refrigerant: Black.
      d. Gas: Black.

C. All above and below grade and interior and exterior valves shall be tagged. Submit valve tag chart to the University Representative for review and approval at the completion of the project.

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

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SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Balancing Air Systems:
      a. Variable-air-volume systems.
   2. Balancing Hydronic Piping Systems:
      a. Variable-flow hydronic systems.
      b. Primary-secondary hydronic systems.
   3. Testing, Adjusting, and Balancing Equipment:
      a. Motors.
      b. Boilers.
      c. Heat-transfer coils.
   4. Testing, adjusting, and balancing existing systems and equipment.
   5. Sound tests.
   6. Vibration tests.
   7. Duct leakage tests.
   8. Control system verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site with the Engineer and Commissioning Agent after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
   1. Minimum Agenda Items:
      a. The Contract Documents examination report.
      b. The TAB plan.
      c. Needs for coordination and cooperation of trades and subcontractors.
      d. Proposed procedures for documentation and communication flow.

1.5 ACTION SUBMITTALS

A. LEED Submittals:
   1. Air-Balance Report for Prerequisite IEQ 1: Documentation indicating that work complies with ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
   2. TAB Report for Prerequisite EA 2: Documentation indicating that work complies with ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: Submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.7 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Engage an independent TAB Contractor certified by AABC, NEBB or TABB.
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC, NEBB or TABB.
   2. TAB Technician: Employee of the TAB specialist and certified by AABC, NEBB or TABB as a TAB technician.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.8 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, 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 operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:
   1. Equipment and systems to be tested.
   2. Strategies and step-by-step procedures for balancing the systems.
   3. Instrumentation to be used.
   4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
   1. Airside:
      a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
      b. Duct systems are complete with terminals installed.
      c. Volume, smoke, and fire dampers are open and functional.
      d. Clean filters are installed.
      e. Fans are operating, free of vibration, and rotating in correct direction.
      f. Variable-frequency controllers' startup is complete and safeties are verified.
      g. Automatic temperature-control systems are operational.
      h. Ceilings are installed.
      i. Windows and doors are installed.
      j. Suitable access to balancing devices and equipment is provided.
   2. Hydronics:
      a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
      b. Piping is complete with terminals installed.
      c. Water treatment is complete.
      d. Systems are flushed, filled, and air purged.
      e. Strainers are pulled and cleaned.
      f. Control valves are functioning per the sequence of operation.
      g. Shutoff and balance valves have been verified to be 100 percent open.
      h. Pumps are started and proper rotation is verified.
      i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
      j. Variable-frequency controllers' startup is complete and safeties are verified.
      k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE Standard 111 or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
   2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:
   1. Verify that the system static pressure sensor is located at least two-thirds of the distance down the duct from the fan discharge or as shown on the Drawings.
   2. Verify that the system is under static pressure control.
   3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
      a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
      b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
      c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
      d. Adjust controls so that terminal is calling for minimum airflow.

e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
   a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
   c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
   d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. Measure fan static pressures as follows:
   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
   a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
   b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
   d. Mark final settings.
   e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
   f. Verify tracking between supply and return fans.
   g. Verify building pressurization control by measuring building pressure at various operating conditions.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
   1. Check liquid level in expansion tank.
   2. Check highest vent for adequate pressure.
   3. Check flow-control valves for proper position.
   4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
   5. Verify that motor starters are equipped with properly sized thermal protection.
   6. Check that air has been purged from the system.

3.7 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. Adjust the variable-flow hydronic system as follows:
   1. Verify that the differential-pressure sensor is located as indicated.
   2. Determine whether there is diversity in the system.

C. For systems with no diversity:
   1. Adjust pumps to deliver total design gpm.
      a. Measure total water flow.
         1) Position valves for full flow through coils.
         2) Measure flow by main flow meter, if installed.
         3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
      b. Measure pump TDH as follows:
         1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
         2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
         3) Convert pressure to head and correct for differences in gage heights.
         4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
         5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
      c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
   2. Adjust flow-measuring devices installed in mains and branches to design water flows.
      a. Measure flow in main and branch pipes.
      b. Adjust main and branch balance valves for design flow.

c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.
4. For systems with pressure-independent valves at terminals:
   a. Measure differential pressure and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.
5. For systems without pressure-independent valves or flow-measuring devices at terminals:
   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
6. Prior to verifying final system conditions, determine the system differential-pressure set point.
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:
   a. Re-measure and confirm that total water flow is within design.
   b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
   c. Mark final settings.
10. Verify that memory stops have been set.

D. For systems with diversity:
   1. Determine diversity factor.
   2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
   3. Adjust pumps to deliver total design gpm.
      a. Measure total water flow.
         1) Position valves for full flow through coils.
         2) Measure flow by main flow meter, if installed.
         3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
      b. Measure pump TDH as follows:
         1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
         2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
         3) Convert pressure to head and correct for differences in gage heights.
         4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
         5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.
   a. Measure flow in main and branch pipes.
   b. Adjust main and branch balance valves for design flow.
   c. Re-measure each main and branch after all have been adjusted.
5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.
6. For systems with pressure-independent valves at terminals:
   a. Measure differential pressure, and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    c. Mark final settings.
13. Verify that memory stops have been set.

3.8 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.

B. Balance the secondary circuits after the primary circuits are complete.

C. Adjust pumps to deliver total design GPM:
   1. Measure total water flow.
      a. Position valves for full flow through coils.
      b. Measure flow by main flow meter, if installed.
      c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
   2. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gage heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

D. Adjust flow-measuring devices installed in mains and branches to design water flows.
1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

E. Adjust flow-measuring devices installed at terminals for each space to design water flows.
1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

F. For systems with pressure-independent valves at terminals:
1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:
1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

H. Verify final system conditions as follows:
1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

I. Verify that memory stops have been set.

3.9 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.

6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.10 PROCEDURES FOR BOILERS

A. Hydronic Boilers:
1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Record relief valve pressure setting.

3.11 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:
1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:
1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:
1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

3.12 SOUND TESTS

A. After the systems are balanced and construction is Substantially Complete, measure and record sound levels at 4 locations as designated by the Architect.

B. Instrumentation:
   1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
   2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (LEQ).
   3. The sound-testing meter must be capable of using 1/3 octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
   4. The accuracy of the sound-testing meter shall be plus or minus one decibel.

C. Test Procedures:
   1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
   2. Equipment should be operating at design values.
   3. Calibrate the sound-testing meter prior to taking measurements.
   4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
   5. Record a set of background measurements in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
   6. Take sound readings in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
   7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.
   8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:
   1. Report shall record the following:
      a. Location.
      b. System tested.
      c. dBA reading.
      d. Sound pressure level in each octave band with equipment on and off.
   2. Plot sound pressure levels on NC worksheet with equipment on and off.

3.13 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer. See specifications section 230593 Metal Ducts for requirements.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.14 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:
   1. Verify temperature control system is operating within the design limitations.
   2. Confirm that the sequences of operation are in compliance with Contract Documents.
   3. Verify that controllers are calibrated and function as intended.

4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.15 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.16 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Prepare monthly reports to recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.17 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.

2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Make and type.

d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat-coil static-pressure differential in inches wg.
   g. Cooling-coil static-pressure differential in inches wg.
   h. Heating-coil static-pressure differential in inches wg.
   i. Outdoor airflow in cfm.
   j. Return airflow in cfm.
   k. Outdoor-air damper position.
   l. Return-air damper position.
   m. Vortex damper position.

F. Apparatus-Coil Test Reports:
1. Coil Data:
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch o.c.
   f. Make and model number.
   g. Face area in sq. ft.
   h. Tube size in NPS.
   i. Tube and fin materials.
   j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
   e. Return-air, wet- and dry-bulb temperatures in deg F.
   f. Entering-air, wet- and dry-bulb temperatures in deg F.
   g. Leaving-air, wet- and dry-bulb temperatures in deg F.
   h. Water flow rate in gpm.

i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.

h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
   a. System and air-handling-unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:
1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Apparatus used for test.
   d. Area served.
   e. Make.
   f. Number from system diagram.
   g. Type and model number.
   h. Size.
   i. Effective area in sq. ft.
2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Air velocity in fpm.
   c. Preliminary airflow rate as needed in cfm.
   d. Preliminary velocity as needed in fpm.
   e. Final airflow rate in cfm.
   f. Final velocity in fpm.
   g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
   1. Unit Data:
      a. System and air-handling-unit identification.
      b. Location and zone.
      c. Room or riser served.
      d. Coil make and size.
      e. Flowmeter type.
   2. Test Data (Indicated and Actual Values):
      a. Airflow rate in cfm.
      b. Entering-water temperature in deg F.
      c. Leaving-water temperature in deg F.
      d. Water pressure drop in feet of head or psig.
      e. Entering-air temperature in deg F.
      f. Leaving-air temperature in deg F.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Service.
      d. Make and size.
      e. Model number and serial number.
      f. Water flow rate in gpm.
      g. Water pressure differential in feet of head or psig.
      h. Required net positive suction head in feet of head or psig.
      i. Pump rpm.
      j. Impeller diameter in inches.
      k. Motor make and frame size.
      l. Motor horsepower and rpm.
      m. Voltage at each connection.
      n. Amperage for each phase.
      o. Full-load amperage and service factor.
      p. Seal type.
   2. Test Data (Indicated and Actual Values):
      a. Static head in feet of head or psig.
      b. Pump shutoff pressure in feet of head or psig.
      c. Actual impeller size in inches.
      d. Full-open flow rate in gpm.
      e. Full-open pressure in feet of head or psig.
      f. Final discharge pressure in feet of head or psig.
      g. Final suction pressure in feet of head or psig.
      h. Final total pressure in feet of head or psig.
      i. Final water flow rate in gpm.
      j. Voltage at each connection.
      k. Amperage for each phase.

M. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.

c. Application.
d. Dates of use.
e. Dates of calibration.

3.18 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of commissioning authority.

B. Commissioning authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:
1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, Owner may contact AABC, NEBB or TABB Headquarters regarding the Performance Guaranty.

F. Prepare test and inspection reports.

3.19 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713- DUCT INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies insulation used on ductwork and plenums.

1.2 QUALITY ASSURANCE

A. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

ASC-A-7001C	Adhesive and Sealant Council Standards for Adhesives for Duct Liner.
ASTM C518	Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
ASTM C553	Mineral Fiber Blanket and Felt Insulation.
ASTM E96	Water Vapor Transmission of Materials.
SMACNA DCS	SMACNA Duct Construction Standards.
UL 723	Surface Burning Characteristics of Building Materials.

B. Materials: Flame spread/smoke developed rating of 25/50 in accordance with UL 723 and UL790.

C. Applicator: Company specializing in performing the work of this section with minimum three years experience.

D. Store insulation in original wrapping and protect from weather and construction traffic.

E. Protect insulation against dirt, water, chemical, and mechanical damage.

F. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

G. Maintain temperature during and after installation for minimum period of 24 hours.

1.3 SUBMITTALS

A. Submit the following under provisions of paragraph 23 05 00-1.11:
   1. Product Data: Provide product description, list of materials and thickness for each service, and locations.
   2. Samples: Submit two samples of any representative size illustrating each insulation type.

PART 2 - PRODUCTS

2.1 GLASS FIBER, FLEXIBLE (INDOOR APPLICATION)

A. Manufacturers: Owens-Corning Fiberglass all-service faced duct wrap, Certainteed, Knauf, Manville or equal.

B. Insulation: ASTM C553; flexible, noncombustible blanket.
1. 'K' ('Ksi') value : ASTM C518, 0.30 at 75°F.
2. Maximum service temperature: 250°F.
3. Maximum moisture absorption: <3% at 120°F.
4. Density: 0.5 lb/cu ft.

C. Vapor Barrier Jacket
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape
1. Manufacturers: Owens-Corning or equal (no known equal).
2. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Tie Wire: Annealed steel, 16 gage.

2.2 CLOSED CELL, FLEXIBLE (FOR OUTDOOR SOUND ATTENUATORS)

A. Flexible Elastomeric Duct Insulation: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Armacell LLC.
b. Aeroflex USA Inc.
c. Rubatex International, LLC.

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
a. For exterior applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Provide 24 gauge galvanized sheet metal jacket over exterior insulation on sides and end.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that ductwork has been tested before applying insulation materials.

B. Verify surfaces are smooth, dry, clean, and free from dust, debris, or other loose materials. Surfaces must be dry before the application of the insulation.

3.2 INSTALLATION

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

B. Deliver products to the job site in manufacturer's original sealed containers with seals and labels intact. All materials shall be stored at job site, in an enclosed space, protected from excessive heat and cold, in accordance with material manufacturer's instructions.

C. Insulated ductwork conveying air below ambient temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

D. The Contractor shall be responsible for providing and installing all protective covers, drops, and masking required to protect adjacent areas, equipment, utilities, parts, material, and other items from spills, mist, spray, etc.

E. The Contractor shall be responsible for the removal of and repairing any damage caused by cleaning chemicals, gravel, dust, coating materials, etc. The contractor shall also be responsible for damage caused by workers, equipment, etc.

3.3 TOLERANCE

A. Substituted insulation materials shall provide thermal resistance within 5 percent at same thermal conditions, as materials indicated.

3.4 FLEXIBLE GLASS FIBER DUCTWORK INSULATION SCHEDULE

DUCTWORK	THICKNESS Inch	FINISH
Indoor Supply Ducts in Non-Conditioned Spaces (delta T >15 deg F)	1-1/2"	Vapor Barrier
Indoor Return Ducts, in Non-Conditioned Spaces (delta T >15 deg F)	1-1/2"	Vapor Barrier
Indoor Supply Ducts In conditioned spaces (delta T < 15 deg F)	1-1/2"	Vapor Barrier
Indoor Return Ducts, In conditioned spaces (delta T < 15 deg F)	1-1/2"	Vapor Barrier

3.5 GLASS FIBER DUCT LINER INSULATION SCHEDULE

DUCTWORK	THICKNESS Inch
All interior supply ducts and plenums	1-1/2
All ducts shown lined on drawings	1-1/2
Indoor Sound Attenuator	1-1/2
VAV Box discharge plenums	1.5
AHU Inlets and Outlets for a distance of 20 ft	11/2
All outdoor supply air ducts	2.0
All outdoor return air ducts	2.0

3.6 CLOSED CELL, FLEXIBLE INSULATION SCHEDULE

DUCTWORK	THICKNESS Inch
Outdoor Sound Attenuator	2.0

END OF SECTION 230713

SECTION 230716 – HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC equipment that is not factory insulated:
   1. Heating, hot-water tanks.
   2. Heating, hot-water air separator.

B. Related Sections:
   1. Section 230713 "Duct Insulation."
   2. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
   1. "No Exception Taken".
   2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field-applied if any).

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail removable insulation at equipment connections.
   3. Detail application of field-applied jackets.
   4. Detail application at linkages of control devices.
   5. Detail field application for each equipment type.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation

materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

1.8 SCHEDULING

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

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

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

D. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide the following:
   a. Pittsburgh Corning Corporation.
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. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

E. Flexible Elastomeric Insulation: Closed-cell. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Armacell LLC.
   b. Aeroflex USA, Inc.
   c. K-Flex USA.
   d. Or equal.

F. 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 foil-scrim-kraft (FSK) jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville.
   b. CertainTeed Corporation.
   c. Owens Corning.
   d. Or equal.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with factory-applied FSK jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville.
   b. CertainTeed Corporation.
   c. Owens Corning.
   d. Or equal.

H. 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 "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville.
   b. CertainTeed Corporation.
   c. Owens Corning.
   d. Or equal

I. Phenolic:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Resolco Inc. Insul-Phen Green.
b. Kingspan Tarec Industrial Insulation NV; Koolphen K or equal.
2. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
4. Factory-Applied Jacket: all service jacket (ASJ).

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Armacell LLC.
b. Aeroflex USA, Inc.
c. K-Flex USA.
d. Or equal.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Brand.
b. Foster Brand.
c. Or equal.

E. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Brand.
b. Foster Brand.
c. Or equal.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Foster Brand.
b. Knauf Insulation.
c. Vimasco Corporation.
d. Or equal

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

2.4 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Zeston.
   b. Proto Corporation; LoSmoke.
   c. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer or equal.
3. Color: White
4. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand
   b. ITW Insulation Systems
   c. RPR Products, Inc.; Insul-Mate or equal.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   a. Sheet and roll stock ready for shop or field sizing.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 1-mil thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.5 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ITW Insulation Systems
   b. RPR Products, Inc.
   c. Or equal.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal.

B. Wire: 0.062-inch soft-annealed, stainless steel.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. C&F Wire.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. 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 on center.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches on center.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. 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.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Blanket Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 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 overcompress 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 bands.
   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 ends around manholes, handholes, ASME stamps, and nameplates.
   10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

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 INSTALLATION OF PHENOLIC INSULATION

A. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.

B. Install two-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 stainless-steel bands at 12-inch intervals.

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-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 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 list shall be submitted to Engineer of Record for review.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Heating-hot-water pump insulation shall be one of the following:
1. Cellular Glass: 3 inches thick.
2. Flexible Elastomeric: 2 inch thick.
3. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

D. Heating-hot-water tank insulation, up to 200 deg F, shall be one of the following:
1. Cellular Glass: 2 inches thick.
2. Mineral-Fiber Board: 1 inch thick and 2-lb/cu. ft. nominal density.
3. Mineral-Fiber Pipe and Tank: 1 inch thick.

E. Heating-hot-water air-separator insulation, up to 200 deg F, shall be one of the following:
   1. Cellular Glass: 2 inches thick.
   2. Mineral-Fiber Board: 1 inch thick and 2-lb/cu. ft. nominal density.
   3. Mineral-Fiber Pipe and Tank: 1 inches thick.

3.8 INDOOR, FIELD-APPLIED JACKET SCHEDULE

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

B. Equipment, Concealed:
   1. None.

C. Equipment, Exposed:
   1. PVC, Color-Coded by System: 20 mils thick.
   2. Painted Aluminum, Stucco Embossed: 0.020 inch thick if exposed to damage.

END OF SECTION 230716

SECTION 230719– HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: This section specifies insulation for exposed piping and related equipment and appurtenant surfaces.

1.2 QUALITY ASSURANCE

A. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

ASTM B209	Aluminum ad Aluminum-Alloy Sheet and Plate.
ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation.
ASTM D1621	Compressive Properties of Rigid Cellular Plastics.
ASTM D1056	Flexible Cellular Materials.
ASTM C921	Jacketing Materials.
ASTM C533	Mineral Fiber Blanket and Felt Insulation.
ASTM C612	Mineral Fiber Block and Board Insulation.
ASTM C449	Mineral Fiber Hydraulic Setting and Finishing Cement.
ASTM C195	Mineral Fiber Thermal Insulating Cement.
ASTM C547	Mineral Fiber Preformed Pipe Insulation.
ASTM C534	Performed Flexible Elastomeric Cellular Thermal Insulation In Sheet and Tubular Form.
ASTM C518	Steady State Heat Flux Measurements.
ASTM C177	Steady State Heat Flux Measurements.
ASTM E84	Surface Burning Characteristics.
ASTM E96	Water Vapor Transmission of Materials.
ASTM D2842	Water Vapor Transmission of Rigid Cellular Plastics.
MICA	National Commercial and Industrial Insulation Standards

B. Applicator: Company specializing in performing the work of this section with minimum three years experience.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

E. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

F. Maintain temperature during and after installation for minimum period of 24 hours.

1.3 SUBMITTALS

A. The following information shall be provided in accordance with paragraph 23 05 00-1.11:
   1. Manufacturer and manufacturer's type designation.
   2. Samples, for each insulation material type, of typical jacket and closures for fittings, valves and appurtenances.
   3. Descriptive literature and catalog data for materials to be used showing methods of installation.

B. Certification of ratings for water vapor transmission and puncture and stiffness.

PART 2 - PRODUCTS

2.1 GENERAL

A. Piping insulation shall be tubular or the flexible blanket type. Insulation for valves, strainers, fittings, expansion joints, flanges and other connections shall be segmented sections, molded, or blanket type coverings of the specified type and thickness of pipe insulation, or the flexible blanket type. Equipment insulation shall be flexible blanket type or rigid board type cut to fit the surface.

2.2 GLASS FIBER

A. Manufacturers: Owens-Corning Fiberglass 25 ASJ/SSL, Certainteed, Knauf or equal.

B. Insulation: ASTM C177; rigid molded, noncombustible.
   1. 'K' value : ASTM C335, 0.23 at 75°F.
   2. Minimum Service Temperature: -20°F.
   3. Maximum Service Temperature: 850°F.
   4. Maximum Moisture Absorption: 0.2 percent by volume.

C. Vapor Barrier Jacket:
   1. ASTM C921, White kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
   3. Secure with self sealing longitudinal laps and butt strips.
   4. Secure with outward clinch expanding staples and vapor barrier mastic.

D. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.

E. Vapor Barrier Lap Adhesive:
   1. Manufacturers: Armstrong, or equal (no known equal).
   2. Compatible with insulation.

F. Insulating Cement/Mastic:
   1. Manufacturers: Armstrong or equal (no known equal).
   2. ASTM C195; hydraulic setting on mineral wool.

G. Fibrous Glass Fabric:
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Blanket: 1.0 lb/cu ft density.

H. Indoor Vapor Barrier Finish:
1. Manufacturers: Owens-Corning or equal (no known equal).
2. Vinyl emulsion type acrylic, compatible with insulation, white color.

I. Outdoor Vapor Barrier Mastic:
1. Manufacturers: Armstrong or equal (no known equal).
2. Vinyl emulsion type acrylic, compatible with insulation, white color.

J. Insulating Cement:
1. Manufacturers: Armstrong or equal (no known equal).
2. ASTM C449.

2.3 GLASS FIBER, FLEXIBLE

A. Manufacturers: Owens Corning, Certainteed, Knauf or equal.

B. Insulation: ASTM C553; flexible, noncombustible.
1. 'K' value : ASTM C177, 0.24 at 75°F .
2. Maximum service temperature: 250°F.
3. Maximum moisture absorption: 0.2 percent by volume.
4. Density: 2.0 lb/cu ft density.

C. Vapor Barrier Jacket:
1. ASTM C921, kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

D. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.

E. Vapor Barrier Lap Adhesive:
1. Manufacturers: Armstrong or equal (no known equal).
2. Compatible with insulation.

F. Insulating Cement/Mastic:
1. Manufacturers: Armstrong or equal (no known equal).
2. ASTM C195; hydraulic setting on mineral wool.

2.4 GLASS FIBER, RIGID

A. Manufacturers: Owens Corning, Certainteed, Knauf or equal.

B. Insulation: ASTM C612; rigid, noncombustible.
1. 'K' value: ASTM C177, 0.24 at 75°F.
2. Maximum service temperature: 850°F.
3. Maximum moisture absorption: 0.1 percent by volume.
4. Density: 3.0 lb/cu ft density.

C. Vapor Barrier Jacket:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.

2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

D. Facing: 1 inch galvanized steel hexagonal wire mesh stitched onto both faces of insulation.

E. Vapor Barrier Lap Adhesive:
1. Manufacturers: Armstrong or equal (no known equal).
2. Compatible with insulation.

F. Insulating Cement/Mastic:
1. Manufacturers: Armstrong or equal (no known equal).
2. ASTM C195; hydraulic setting on mineral wool.

2.5 CELLULAR FOAM

A. Manufacturers: Armaflex, Rubatex, or equal.

B. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
1. 'K' value: ASTM C177 or C518; 0.28 at 75 °F.
2. Minimum service temperature: -40 °F .
3. Maximum service temperature: 220 °F.
4. Maximum moisture absorption: ASTM D1056; 3.0 percent (pipe) by volume, 6.0 percent (sheet) by volume.
5. Moisture vapor transmission: ASTM E96; 0.20 perm inches.
6. Maximum flame spread: ASTM E84; 25.
7. Maximum smoke developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive:
1. Manufacturers: Armstrong 520 or equal (no known equal).
2. Air dried, contact adhesive, compatible with insulation.

2.6 INSERTS

A. Polyurethane Rigid Foam Insulation:
1. Manufacturer: Trymer 9501, Insul Therm or equal.
2. Insulation:
   a. Minimum Service Temperature: -320°F.
   b. Maximum Service Temperature: 300°F.
   c. Moisture Absorption: ASTM D2842, .05 lb/ft2.
   d. "K" value: ASTM C518; 0.14 at 75°F.
   e. Maximum Flame Spread: ASTM E-84; 20.
   f. Maximum Smoke Density: ASTM E-84; 50.
   g. Compressive Strength: ASTM D-1621; 28 parallel, 20 perpendicular.

B. Hydrous Calcium Silicate:
1. Manufacturer: Pabco Super Caltemp or equal.
2. Insulation: ASTM C533; rigid molded white; asbestos free.
   a. "K" value: ASTM C177 and C518; 0.40 at 300°F.

b. Maximum Service Temperature: 1,200°F.
c. Density: 14 lb/cu. ft.

2.7 JACKETS

A. Indoor - PVC Plastic:
1. Manufacturers for White PVC Jackets shall be Proto Corp. LoSMOKE 20, Ceel-Co 550, Foster's Speedline 25/50 or equal.
2. Jacket: ASTM C921, One piece molded type fitting covers and jacketing; high gloss white color unless otherwise indicated.
a. Minimum Service Temperature: 0°F.
b. Maximum Service Temperature: 150°F.
c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
d. Maximum Flame Spread: ASTM E84; 25.
e. Maximum Smoke Developed: ASTM E84; 50.
f. Thickness: 0.020 inch.
g. Connections: Vapor seal mastic.
3. Covering Adhesive Mastic:
a. Manufacturers: Manville Zeston Perma-Weld, Ceel-Co 300 or equal.
b. Compatible with insulation and jacket.

B. Outdoor - Aluminum Jacket: ASTM B209
1. Thickness: 0.020 inch sheet.
2. Finish: Embossed.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: 0.020 inch thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 1/2 inch wide; 0.010 inch thick aluminum.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Insulation shall be applied over clean, dry surfaces. Double layout insulation, where specified or required to achieve the specified surface temperature, shall be provided with staggered section joints.

B. Pipe Supports and Shields: Unless otherwise specified, thermal pipe hanger shields shall be provided by the Contractor and installed during pipe support installation. Where thermal pipe hanger shields are used, apply the following to all butt joints:
1. On cold water, the Contractor shall apply a wet coat of vapor barrier lap cement on all butt joints and seal the joints with a minimum 3 inch wide vapor barrier tape or band.

C. Protection: Insulation and jackets shall be protected from crushing, denting, and similar damage during construction. Vapor barriers, shall not be penetrated or otherwise damaged. Insulation, jacket, and vapor barriers damaged during construction shall be removed and new material shall be installed.

D. Piping Insulation:
1. General:

a. Pipe: Piping shall be continuously insulated with Glass Fiber specified in paragraph 23 07 00-2.02, along its entire length including in-line devices such as valves, fittings, flanges, couplings, strainers, triple-duty valves and other piping appurtenances. Insulation shall be butted firmly together and jacket laps and joint strips provided with lap adhesive. Jackets shall be provided with their seams located on the topside of pipe for pipes located at least five feet above finished floor. Pipes located below five feet above finished floor shall be provided with their seams located underneath the pipe. Removable flexible blanket-type insulation need not be jacketed. Continue insulation through walls, sleeves, pipe hammers, and other pipe penetrations.
b. Fittings, Connections, Flanges and Valves: Fitting, connection, flange and valve insulation shall be insulated with Glass Fiber (Flexible or Rigid) specified in paragraph 23 07 00-2.03 and 2.04, provided with jackets specified in paragraph 23 07 00-2.07. Insulation shall be secured in place with 20-gage wire and a coat of insulating cement. Jackets shall be provided with their seams located on the underside of fittings and valves.

2. Insulated Cold Pipes Conveying Fluids Below Ambient Temperatures:
   a. Pipe: Refer to Section 2.05.
   b. Fittings, Connections, Flanges and Valves: Refer to Section 2.05.
3. Insulated Pipes Conveying Fluids Above Ambient Temperature:
   a. Pipe: Provide standard jackets, with or without vapor barrier, factory or field applied. Refer to MICA Plate No. 36.
   b. Fittings, Flanges, and Valves: Insulation shall be covered with PVC jackets specified in paragraph 23 07 00-2.07-A. The ends of jackets shall be secured with PVC end caps (trimmed away from valve stem). Refer to MICA Plate No 12 (fittings) and No. 15 (valves). Covers shall be secured with adhesive.
   c. For hot piping conveying fluids 140°F or less, do not insulate flanges and unions at equipment, but bevel and seal end of insulation.
   d. For hot piping conveying fluids over 140°F, insulate flanges and unions at equipment.
4. Outdoor Piping:
   a. Pipe: Rigid insulation shall be provided with aluminum jackets specified in paragraph 23 07 00-2.07-B unless otherwise indicated. Flexible blanket-type insulation shall be designed for outdoor, weather-exposed service. Refer to MICA Plate No. 6.
   b. Fittings, Connections, Flanges and Valves: Rigid insulation shall be provided with rigid aluminum covers specified in paragraph 23 07 00-2.04-B. Flexible blanket-type insulation shall be designed for outdoor, weather-exposed service. Refer to MICA Plate No. 17 (fittings) and No 14 (valves).
   c. Provide aluminum jacket for all exterior piping.
5. Inserts and Shields:
   a. Inserts for piping conveying fluids below ambient temperature shall be polyurethane as specified in paragraph 23 07 00-2.06-A.
   b. Inserts for piping conveying fluids above ambient temperature shall be polyurethane or calcium silicate as specified in paragraph 23 07 00-2.06.
   c. Application: Piping 2" diameter or larger.
   d. Shields: Minimum 18 gauge galvanized steel between hangers and inserts.
   e. Insert Location: Between support shield and equipment and under the finish jacket.

f. Insert Configuration: Minimum 6" long, of same thickness and contour as adjoining insulation; may be factory fabricated.

6. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
7. Install insulation for equipment requiring access for maintenance, repair, or cleaning in such a manner that it can be easily removed and replaced without damage.

E. Mechanical Equipment Insulation:

1. General: Unless otherwise specified, insulation shall be Glass Fiber (Flexible and Rigid) specified in paragraph 23 07 00-2.03 and 2.04. Wrap equipment with fiberglass blanket and build box around equipment with 1-1/2" thick fiberglass board. Weld pins or stick clips with washers may be used for flat surfaces and spaced a maximum 18 inches apart. Joints shall be staggered and voids filled with insulating cement. Unless specifically specified to be un-insulated, equipment connected to insulated piping shall be insulated.
2. Low Temperature Class: Insulation shall have joints, breaks, and punctures sealed in facing with fire-retardant vapor barrier adhesive reinforced with 4 inch tape. Insulation shall be provided with a layer of open-weave glass cloth embedded into a wet coat of fire-retardant adhesive. Seams shall overlap at least 2 inches. A finish coat of fire-retardant adhesive shall be provided.

F. Flashing:

1. Flashing shall be provided at jacket penetrations and terminations. Clearance for flashing shall be provided between insulation system and supports.
2. A heavy tack coat of sealant shall be troweled over the insulation, extending over the jacket edge 1 inch, and over the pipe protrusion 2 inches. Reinforcement shall be stretched over the tack coat after clipping to fit over pipe and jacket. Clipped reinforcing shall be strapped with a continuous band of reinforcing to prevent curling. Sealant shall be troweled over the reinforcement to a minimum thickness of 1/8 inch.
3. Aluminum caps shall be formed to fit over the adjacent jacketing and to completely cover coated insulation. Cap shall be held in place with a jacket strap.

3.2 PIPING INSULATION

A. The insulation dimensional tolerances shall comply with the specified standards. Unless otherwise indicated, equipment insulation shall match thickness of attached piping. The minimum insulation thickness exclusive of jacket, and insulation jacket colors shall be as follows:

Service	Piping Service Range°	1" and Less	1.25" to 2"	2.50" to 4"	5" and 6"	8" and Larger	PVC Jacket Color
CHWR	45-60	1.0	1.0	1.0	1.0	1.0	Gloss White
CHWS	38-48	1.0	1.0	1.0	1.5	1.5	Gloss White
HHWR	120-180	1.0	1.0	1.0	1.5	2.0	Gloss White
HHWS	160-210	1.0	1.0	1.0	1.5	2.0	Gloss White
Domestic HW Supply	105-140	0.5	1.0	1.0	-	-	N/A
Domestic HW Return	100-130	0.5	1.0	1.0	-	-	N/A
Domestic Cold Water	55-75	0.5	0.5	0.5	-	-	N/A
Condensate Drains (indoor and above ceilings)	50-65	0.5	0.5	0.5	-	-	N/A

Use pre-formed rigid pipe insulation with ASJ vapor barier. Use PVC jackets indoors at fittings to complete the vapor barrier, and aluminum jackets outdoors for piping and fittings to create a vapor proof barrier. Seal all joints vapor tight.

3.3 EQUIPMENT INSULATION SCHEDULE

A. Cooling and Heating Systems

Air Separators	1.0 inch rigid fiberglass, or 1.5 inches of blanket fiberglass
Pumps	1.0 inch rigid fiberglass, or 1.5 inches of blanket fiberglass
Valves	1.0 inch rigid fiberglass, or 1.5 inches of blanket fiberglass

END OF SECTION 230719

SECTION 230800 - COMMISSIONING OF HVAC

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 commissioning process requirements for the following HVAC&R systems, assemblies, and equipment:
   1. Heat generation systems, including hot-water boilers.
   2. Distribution systems, including air distribution (heating and cooling) systems, hot-water distribution systems, exhaust systems, and air-handling units.
   3. Terminal and packaged units, including heat pumps.
   4. Vibration and sound systems, including sound attenuation vibration isolation devices seismic restraints.
   5. Controls and instrumentation, including energy monitoring and control system.
   6. Systems testing and balancing verification, including heating-water piping systems domestic hot-water circulating systems supply-air systems return-air systems exhaust-air systems.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. DDC: Direct digital controls.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. "Systems," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

E. TAB: Testing, adjusting, and balancing.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For BAS and HVAC&R Testing Technician.

B. Construction Checklists: See related Sections for technical requirements for the following construction checklists:
   1. Vibration and seismic controls for HVAC&R piping and equipment.
   2. Instrumentation and control for HVAC&R.

3. Heating-water piping and accessories.
4. Cooling-water piping and accessories.
5. Refrigerant piping.
6. Metal ducts and accessories.
7. Fans.
8. Particulate air filtration.
9. Air-handling units.
10. Boilers.
11. Pumps.

1.5 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:
   1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
   2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
   3. International Society of Automation (ISA) Certified Control Systems Technician (CCST) Level I.

B. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:
   1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associates degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.
   2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
   3. One of the following:
      a. National Environmental Balancing Bureau (NEBB) Certified Testing, Adjusting, and Balancing Technician.
      b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.
      c. Owner retains the right to waive NEBB or AABC Certification.

C. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:
   1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:
      a. Equipment/instrument identification number.
      b. Planned commissioning application or use.
      c. Manufacturer, make, model, and serial number.
      d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
   2. Test equipment and instrumentation shall meet the following criteria:

a. Capable of testing and measuring performance within the specified acceptance criteria.
b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:
1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:
a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:
1) Instrument or tool identification number.
2) Equipment schedule designation of equipment for which the instrument or tool is required.
3) Manufacturer, make, model, and serial number.
4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.
b. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.
c. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents and approved Shop Drawings and submittals.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.

F. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.

G. Construction Checklists: Prepare and submit detailed construction checklists for HVAC&R systems, subsystems, equipment, and components.
   1. Contributors to the development of construction checklists shall include, but are not limited to, the following:
      a. HVAC&R systems and equipment installers.
      b. TAB technicians.
      c. HVAC&R instrumentation and controls installers.

H. Perform tests using design conditions, whenever possible.
   1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by Commissioning Coordinator and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
   2. Commissioning test procedures may direct that set points be altered when simulating conditions is impractical.
   3. Commissioning test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.

J. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

K. Coordinate schedule with, and perform the following activities at the direction of, Commissioning Coordinator.

L. Comply with construction checklist requirements, including material verification, installation checks, start-up, and performance tests requirements specified in Sections specifying HVAC systems and equipment.

M. Provide technicians, instrumentation, tools, and equipment to complete and document the following:
   1. Performance tests.
   2. Demonstration of a sample of performance tests.
   3. Commissioning tests.
   4. Commissioning test demonstrations.

3.2 TAB COMMISSIONING TESTS

A. TAB Verification:
1. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
3. Scope: HVAC&R air systems and hydronic piping systems.
4. Purpose: Differential flow relationships intended to maintain air pressurization differentials between the various areas of Project.
5. Conditions of the Test:
   a. Commissioning Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
   b. Systems operating in full heating mode with minimum outside-air volume.
   c. Systems operating in full cooling mode with minimum outside-air volume.
   d. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.
6. Acceptance Criteria:
   a. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
   b. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.
   c. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

3.3 HEATING CONTROL SYSTEM COMMISSIONING TESTS

A. Heating-Water Supply Temperature Control:
1. Prerequisites: Installation verification of the following:
   a. Startup of boilers.
   b. Startup of heating-water pump(s).
   c. TAB of heating-water flow and pressure.
   d. Input Device: Heating-water supply temperature.
   e. Output Device: Control valve.
   f. Display the following at the operator's workstation:
      1) Heating-water supply temperature.
      2) Heating-water supply temperature set point.
      3) Control-valve position.
2. Scope: Heating-water system.
3. Purpose: Control of heating-water supply temperature at input device.
4. Conditions of the Test:
   a. Minimum heating-water flow.
   b. Midrange Heating-Water Flow: 50 to 60 percent of maximum.
   c. Maximum heating-water flow.
5. Acceptance Criteria: Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F of set point.

B. Heating-Water Supply Temperature Reset:
   1. Prerequisites: Installation verification of the following:
      a. Startup of boilers.
      b. Startup of heating-water pump(s).
      c. TAB of heating-water flow and pressure.
      d. Input Device: Heating-water supply temperature.
      e. Input Device: Outdoor-air temperature.
      f. Output Device: Control valve.
      g. Display the following at the operator's workstation:
         1) Outdoor-air temperature.
         2) Heating-water supply temperature.
         3) Heating-water supply temperature set point.
         4) Control-valve position.
   2. Scope: Heating-water system.
   3. Purpose: Control of heating-water supply temperature at heating-water supply temperature input device in response to variable outdoor-air temperature input;.
   4. Conditions of the Test: Outdoor-air temperature input value may be overridden for this test.
      a. Low Temperature: Outdoor-air temperature between minus 30 and 0 deg F.
      b. Midrange Temperature: Outdoor-air temperature between 30 and 45 deg F.
      c. High Temperature: Outdoor-air temperature above 65 deg F.
   5. Acceptance Criteria: Heating-water supply temperature resets in straight-line relationship with outdoor-air temperature for the following reset schedule. Under all conditions, heating-water supply temperature is within 2.0 deg F of set point.
      a. Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F of set point.

C. Control Primary Circulating Pump(s):
   1. Prerequisites: Installation verification of the following:
      a. Startup of heating-water pump(s).
      b. Input Device: Outdoor-air temperature.
      c. Output Device: Heating-water pump; DDC system command to starter relay.
      d. Display the following at the operator's workstation:
         1) Outdoor-air temperature.
         2) Operating status of primary circulating pump(s).
   2. Scope: Heating-water pump(s) and associated controls.
   3. Purpose: On-off control of heating-water pump(s) in response to variable outdoor-air temperature input;.
   4. Conditions of the Test:
      a. High Temperature: Outdoor-air temperature above 65 deg F.
      b. Low Temperature: Outdoor-air temperature below 65 deg F.
   5. Acceptance Criteria:
      a. High Temperature: Pump(s) are off when outside-air temperature is above 65 deg F.
      b. Low Temperature: Pump(s) are on when outside-air temperature is below 65 deg F.

3.4 TERMINAL UNIT EQUIPMENT COMMISSIONING TESTS

A. Variable-Air-Volume Terminal Air Units with Coils:

1. Prerequisites: Installation verification of the following:
   a. Occupancy Input Device: Occupancy sensor.
   b. Occupancy Output Device: DDC system binary output.
   c. Room Temperature Input Device: Room thermostat.
   d. Room Temperature Output Device: Electronic damper actuators and control-valve operators.
   e. Display the following at the operator's workstation:
      1) Room/area served.
      2) Room occupied/unoccupied.
      3) Room temperature indication.
      4) Room temperature set point.
      5) Room temperature set point, occupied.
      6) Room temperature set point, unoccupied.
      7) Air-damper position as percentage open.
      8) Control-valve position as percentage open.
2. Scope: Variable-air-volume terminal air units with hydronic coils in supply-air systems, and associated controls.
3. Purpose:
   a. Occupancy-dependent room temperature set-point reset.
   b. Room temperature control.
4. Conditions of the Test:
   a. Commissioning Test Demonstration Sampling Rate: 10 percent of each model/size unit.
   b. Temperature Control - Occupied: Start with the room unoccupied. Occupy the room and observe the change to occupied status. Observe temperature control until room temperature is stable at occupied set point plus or minus 1.0 deg F.
   c. Temperature Control - Unoccupied: Start with the room occupied. Vacate the room and observe the change to unoccupied status. Observe temperature control until room temperature is stable at unoccupied set point plus or minus 1.0 deg F.
5. Acceptance Criteria:
   a. Temperature Control - Occupied:
      1) Control system status changes from "occupied" to "unoccupied" after the specified time.
      2) Room temperature is stable at occupied set point plus or minus 1.0 deg F within 10 minutes of occupancy. Room temperature does not overshoot or undershoot set point by more than 2.0 deg F during transition.
   b. Temperature Control - Unoccupied:
      1) Control system status changes from "unoccupied" to "occupied" after five minutes of continuous occupancy.
      2) Room temperature is stable at unoccupied set point plus or minus 1.0 deg F within 30 minutes of occupancy.

3.5 AIR-HANDLING SYSTEM COMMISSIONING TESTS

A. Supply Fan(s) Variable-Volume Control:
   1. Prerequisites: Installation verification of the following:
      a. Volume Control Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to conditioned-space static pressure.
      b. Volume Control Output Device: Receiver controller to modulating damper actuator.

c. High-Pressure Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.
d. High-Pressure Output Device: Receiver controller to motor starter.
e. Display the following at the operator's workstation:
1) Supply-fan-discharge static-pressure indication.
2) Supply-fan-discharge static-pressure set point.
3) Supply-fan airflow rate.
4) Supply-fan speed.

2. Scope: Variable-air-volume supply fan units and associated controls.
3. Purpose:
a. Supply-air discharge static pressure control.
b. Response to excess supply-air discharge static pressure condition.
4. Conditions of the Test:
a. Minimum supply-air flow.
b. Midrange Supply-Air Flow: 50 to 60 percent of maximum.
c. Maximum supply-air flow.
d. Excess supply-air discharge static pressure.
5. Acceptance Criteria:
a. At all supply-air flow rates, and during changes in supply-air flow, discharge air static pressure is at set point plus or minus 2 percent.
b. Fan stops and an alarm is initiated at the operator's workstation when supply-air discharge static pressure is at the excess static pressure plus or minus 2 percent.

END OF SECTION 230800

SECTION 230900 - BUILDING MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 GENERAL OVERVIEW:

A. The control system shall consist of a high-speed, peer-to-peer network of BACnet IP and MSTP field level controllers, building level Java Application Control Engine (JACE) Global Controllers, and seamless integration of building level controllers with an existing RSCCD Tridium Building Management System Server utilizing the Niagra Platform.

B. The existing Tridium Niagra AX Supervisor, S-AX-100, is installed on a campus virtual server currently located at Santiago Canyon College and is supported by RSCCD ITS. The server includes Niagra Historical Databases and Workplaces AX, OBIX client/server drivers for connecting to Niagra-based controllers such as the Vykon JACE Global Controller. The software is licensed to the RSCCD with no license restrictions. Each building shall have its own JACE Global Controller of differing modules at the building level. The JACE is the building level controller which connects to systems as defined in the contract documents.

C. Systems shall use the BACnet protocol for communication to the operator workstations and we server and for communication between control modules. I/O points, schedules, set-points, trends and alarms specified in Sequence of Operation shall be BACnet objects.

1.2 WORK INCLUDED:

A. GENERAL - Building Management System (BMS) Contractor shall provide and install:
   1. A fully integrated Building Automation System (BAS), incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified.
   2. Complete temperature control system to be DDC with electric actuation as specified herein.
   3. All wiring, conduit, panels, and accessories for a complete operational system.
   4. BMS Contractor shall be responsible for all electrical work associated with the BMS. Refer to Division 26 - Electrical for power to control panels.
      a. Perform all wiring in accordance with all local and national codes.
      b. Install all line voltage wiring, concealed or exposed, in conduit in accordance with Division 26 - Electrical, NEC and local building code.
      c. Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers and operator's workstations.
      d. All low voltage electrical control wiring throughout the building when exposed or in an un-accessible location shall be run in conduit in accordance with Division 26 - Electrical, local building code and the NEC. Low voltage wiring throughout the building, when in concealed accessible locations, can be run using plenum rated wire and supported from duct work or ceiling supports, or run in existing cable tray.
   5. All wells for water monitoring devices, flow switches and alarms, as required.

6. Provide open communications system. The system shall be an open architecture with the capabilities to support a multi-vendor environment. To accomplish this effectively, system shall be capable of utilizing standard protocols as follows as well as be able to integrate third-party systems via existing vendor protocols.
   a. System shall be capable of high speed Ethernet communication using TCP/IP protocol.
   b. System shall be capable of BACnet communication according to ANSI/ASHRAE 135-2004.
   c. System shall be capable of OPC server communications according to OPC Data Access 2.0 and Alarms and Events 1.0.
   d. The system shall be capable of supporting both standard and vendor specific protocols to integrate a wide variety of third-party devices and legacy systems.
   e. The system shall be capable of supporting wireless field level networks and sensor communications using a mesh topology and IEEE 802.15.4 network.
   f. Existing Operator Workstations in the Central may be used. Additional site licenses may also be required. Contractor shall coordinate with the Owner's Representative to determine the needs of the project.
7. Provide system graphics for each controlled device and/or integrated systems as required by the owner. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.
8. Stand-alone Application Specific Controllers (ASCs) for terminal equipment (CAV, VAV, fan coil units, heat pumps, AC units, fume hoods, etc).

B. GENERAL PRODUCT DESCRIPTION
1. 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.
2. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specially for this project.
3. The system shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.
4. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.
5. DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC Controllers shall also be able to send alarm to multiple operator workstations without dependence upon a central or intermediate processing device.
6. DDC Controllers shall be able to assign password access and control priorities to each point individually. The logon password (at any PC workstation or portable operator

terminal) shall enable the operator to monitor, adjust or control only the points that the operator is authorized for. All other points shall not be displayed at the PC workstation or portable terminal. (e.g. all base building and all tenant points shall be accessible to any base building operators, but only certain base building and tenant points shall be accessible to tenant building operators). Passwords and priority levels for every point shall be fully programmable and adjustable.

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Hydronic Piping:
   1. Control Valves
   2. Temperature Sensor Wells and Sockets
   3. Flow Switches
   4. Flow Meters
   5. Differential Pressure Transmitters

B. Refrigerant Piping:
   1. Pressure and Temperature Sensor Wells and Sockets

C. Duct-work Accessories:
   1. Air-flow Stations in ductwork. Air flow stations mounted in AHU's or fans are supplied and mounted by unit or fan manufacturer.
   2. Terminal Unit Controls

1.4 PRODUCTS INTEGRATED BUT NOT FURNISHED OR INSTALLED UNDER THIS SECTION

A. Heat Generation Equipment:
   1. Boiler Controls if available from boiler manufacturer.

B. Variable Frequency Drives:

C. BACnet System
   1. Server
   2. Client

D. Lighting Controls

E. Electric meters and submeters

F. Gas meters

G. Domestic water meters

1.5 RELATED SECTIONS

A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.

1.6 QUALITY ASSURANCE

A. The BAS system shall be designed and installed, commissioned and serviced by factory trained personnel. BMS contractor shall have an in-place support facility within 250 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. The B.M.S. contractor shall provide full time, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the B.M.S. The PM should be available by cell phone during normal working hours and on-site when directed for related meetings and coordination. The bidder shall be regularly engaged in the installation and maintenance of BMS systems and shall have a minimum of twenty (20) years of demonstrated technical expertise and experience in the installation and maintenance of B.M.S. systems similar in size and complexity to this project in the greater Los Angeles/Southern California area.

B. The BMS contractor shall have established a 10-year working relationship with control manufacture and evidence of successful prior performance and Tridium installation and integration.

C. The BMS contractor shall maintain an established service organization consisting of factory trained service personnel and provide a list of 10 projects, similar in size and scope to this project, completed within the last five years. Upon request, BMS contractor shall present record of completed Tridium certification training and/or field controller training for control system, including course outlines for review by the District.

D. 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.

E. All BAS peer-to-peer network controllers, central system controllers, and local user displays shall be UL Listed under Standard UL 916, category PAZX; Standard ULC C100, category UUKL7; and under Standard UL 864, categories UUKL, UDTZ, and QVAX and be so listed at the time of bid. All floor level controllers shall comply, at a minimum, with UL Standard UL 916 category PAZX; Standard UL 864, categories UDTZ, and QVAX and be so listed at the time of Bid.

F. The BAS peer-to-peer network controllers and local user display shall also comply with the European Electromagnetic Compatibility (EMC) Framework, and bear the C-Tic Mark to show compliance. The purpose of the regulation is to minimize electromagnetic interference between electronic products, which may diminish the performance of electrical products or disrupt essential communications.

G. DDC peer-to-peer controllers shall be compliant with the European EMC Directive, Standards EN 50081-2 and EN 50082-2, at the Industrial Levels. Additionally the equipment shall be

compliant with the European LVD Directive and bear the CE mark in order to show compliance to both directives.

H. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

I. All wireless devices, if used, shall conform to:
   1. The requirements of Title 47 of the Code of Federal Regulations, FCC Part 15, governing radio frequency intentional radiating devices and be issued a FCC user identification and be so labeled.

J. 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-14001 (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.

K. 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. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network. 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.

1.7 CODES AND STANDARDS

A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:
   1. National Electric Code (NEC)
   2. Uniform Building Code (UBC)
      a. Section 710.5, Wiring in Plenums
      b. Section 1106, Refrigeration Machinery Rooms
      c. Section 1107, Refrigeration Machinery Room Ventilation
      d. Section 1108, Refrigeration Machinery Room Equipment and Controls
   3. Uniform Mechanical Code (UMC)
   4. ANSI/ASHRAE Standard 135- 2004, BACnet--A Data Communication Protocol for Building Automation and Control Networks

1.8 SYSTEM PERFORMANCE

A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).
   1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.

2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 45 sec.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
7. Performance. Programmable controllers shall be able to completely execute DDC control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
8. Multiple-Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.

1.9 SUBMITTALS

A. Product Submittal Requirements. Meet requirements of Section 25 03 00 on Shop Drawings, Product Data, and Samples. Provide four copies of shop drawings and other submittals on hardware, software, and equipment to be installed or furnished. Begin no work until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD 2004 (or newer) compatible files on optical disk (file format: .dwg, .dxf, .vsd, or comparable) or hard copies on 11" x 17" prints of each drawing. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work.

B. Provide submittals within 12 weeks of contract award.

C. Submittal data shall consist of the following:
   1. Direct Digital Control System Hardware:
      a. Complete bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
      b. Manufacturer's description and technical data, such as product specification sheets, installation and maintenance instructions for items listed below and for relevant items not listed below:
         1) Direct Digital Controllers (controller panels)
         2) Transducers and transmitters
         3) Sensors (including accuracy data)
         4) Valves
         5) Dampers
         6) Relays and Switches
         7) Control Panels
         8) Power Supplies
         9) Operator Interface Equipment including workstations, portable laptops, monitors, and printers

c. Wiring diagrams and layouts for each control panel. Show all termination numbers.
d. Floor plan schematic diagrams indicating control panel and space temperature sensor locations.

2. Central System Hardware and Software:
   a. Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used.
   b. Manufacturer's description and technical data such as product specifications for items listed below and for relevant items furnished under this contract not listed below:
      1) Central Processing Unit (CPU)
      2) Monitors
      3) Keyboards
      4) Power Supply
      5) Battery Backup
      6) Interface Equipment Between CPU and Control Panels
      7) Operating System Software
      8) Operator Interface Software
      9) Color Graphic Software
      10) Third-Party Software
      11) Alarm and network printers
   c. Schematic diagrams of all control, communication, and power wiring for central system installation. Show interface wiring to control system.
   d. Provide a list of BMS point naming convention. Indicate the format, structure and standards of typical point names. The naming convention shall follow the "Building_Floor_Equipment_Function" format. Provide a list of point names for typical equipment and functions with specific examples.
3. Controlled Systems:
   a. Riser diagrams showing control network layout, communication protocol, and wire types.
   b. Schematic diagram of each controlled system. Label control points with point names. Graphically show locations of control elements.
   c. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic use the same name.
   d. Instrumentation list for each controlled system. List control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
   e. Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system.
   f. Point list for each system controller including both inputs and outputs (I/O), point numbers, controlled device associated with each I/O point, and location of I/O device.
4. Description of process, report formats and checklists to be used in Part 3: "Control System Demonstration and Acceptance."
5. Contractor shall submit documentation in the following phased delivery schedule:
   a. Valve and damper schedules
   b. Point Naming Convention
   c. Sample Graphics
   d. System schematics, including:
      1) System Riser Diagrams

2) Sequence of Operations
3) Mechanical Control Schematics
4) Electrical Wiring Diagrams
5) Control Panel Layouts
6) Product Specification Sheets

e. As-Built drawings

D. Project Record Documents: Submit three copies of record (as-built) documents upon completion of installation. Submittal shall consist of:

1. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD 2004 (or newer) compatible files on optical media and as 11" x 17" prints.
2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Part 3: "Control System Demonstration and Acceptance."
3. Operation and Maintenance (O & M) Manual.
   a. As-built versions of the submittal product data.
   b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
   c. Operator's Manual with procedures for operating control systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
   d. Programming manual or set of manuals with description of programming language and of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
   e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
   f. Documentation of all programs created using custom programming language, including set points, tuning parameters, and object database.
   g. Graphic files, programs, and database on magnetic or optical media.
   h. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
   i. Complete original original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
   j. Licenses, guarantees, and warranty documents for equipment and systems.

E. Training Materials. Provide course outline and manuals at least four weeks before training.

1.10 WARRANTY

A. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Failures on control systems that include all computer equipment, transmission equipment and all sensors and control devices during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request. If opposite seasons testing is required per 230593 to test during near-peak summer and/or winter conditions, provide support during warranty phase.

B. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

C. If Engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.

D. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with the above-mentioned items. Do not install updates or upgrades without Owner's written authorization.

E. Exception:
1. Contractor shall not be required to warrant reused devices, except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.
2. Contractor shall not be required to warrant systems, equipment and devices or software if the damages and/or failures were caused by lack of training, unauthorized use, negligence or deliberate action of other parties, or job site conditions.

PART 2 - PRODUCTS

2.1 APPROVED CONTROL SYSTEM CONTRACTORS

A. The following are the approved Control System Contractors and Manufacturers:
1. Delta Controls with Tridium front end.
2. Or equal.
3. System must match existing using campus standards as dictated by this specification. Gateway, integrator, or "blackbox" communications interfaces are not acceptable. All functionality of the System 600 Apogee shall be provided at new and existing workstations including but not limited to: trending, archiving, custom reporting, system profiler, programming scheduling etc.

2.2 MATERIALS:

A. All products used in this project installation shall be new and currently manufactured and shall have been applied in similar installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner or Owner's representative. Spare parts shall be available for at least five years after completion of this contract.

2.3 COMMUNICATION:

A. The design of the BMS shall support networking of operator workstations and Building Controllers. The network architecture shall consist of two levels, an Ethernet based primary

network for all operator workstations, servers, and primary DDC controllers along with secondary Floor Level Networks (FLN) for terminal equipment application specific controllers. The Ethernet network will use the campus backbone whenever possible. Contractor will coordinate with the campus IT personnel to locate and identify proper connections.

1. Ethernet connections will use a campus standard 3 port faceplate, with two ports configured and enabled. One shall be for the Management Level Network, and shall be connected to the field panel. The second port shall be for connection of a laptop computer for field panel operations and troubleshooting. Contractor shall coordinate with campus IT for assignment of static IP addresses.

B. Access to system data shall not be restricted by the hardware configuration of the building management system. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control programs.

C. Operator Workstation Communication:
1. All color graphic operator workstations shall reside on the Ethernet network and the consoles shall be set up in a client/server configuration.
2. The servers will act as the central database for system graphics and databases to provide consistency throughout all system workstations.
3. The network shall allow concurrent use of multiple BMS software site licenses.

D. Management Level Network Communication (MLN)
1. All PCs shall simultaneously direct connect to the Ethernet Management Level Network without the use of an interposing device.
2. Operator Workstation shall be capable of simultaneous direct connection and communication with BACnet/IP, OPC and TCP/IP corporate level networks without the use of interposing devices.
3. The Management Level Network shall not impose a maximum constraint on the number of operator workstations.
4. Any controller residing on the primary building level networks shall connect to Ethernet network without the use of a PC or a gateway with a hard drive.
5. Any PC on the Management Level Network shall have transparent communication with controllers on the building level networks connected via Ethernet.
6. Any break in Ethernet communication from the PC to the controllers on the building level networks shall result in a notification at the PC.
7. The standard client and server workstations on the Management Level Network shall reside on industry standard Ethernet utilizing standard TCP/IP, IEEE 802.3.
8. System software applications will run as a service to allow communication with Primary Network Controllers without the need for user log in. Closing the application or logging off shall not prevent the processing of alarms, network status, panel failures, and trend information.
9. Any break in Ethernet communication between the standard client and server workstations on the Management Level Network shall result in a notification at each workstation.
10. Access to the system database shall be available from any standard client workstation on the Management Level Network.

E. Primary Network - Panel to Panel Communication:
1. All Building Controllers shall directly reside on the primary BACnet/IP Ethernet network such that communications may be executed directly between Building Controllers, directly between server and Building Controllers on a peer-to-peer basis.

2. Systems that operate via polled response or other types of protocols that rely on a central processor, file server, or similar device to manage panel-to-panel or device-to-device communications shall not be acceptable.
3. All operator interfaces shall have the ability to access all point status and application report data or execute control functions for any and all other devices. Access to data shall be based upon logical identification of building equipment. No hardware or software limits shall be imposed on the number of devices with global access to the network data.
4. The primary network shall use BACnet/IP over Ethernet. All devices must:
   a. Auto-sense 10/100 Mbps networks.
   b. Be configured with a Fixed IP Address.
   c. Resolve Name to IP Addresses for devices using a Domain Name Service (DNS) Server on the Ethernet network.
   d. Allow MMI access to an individual Primary Network Controller using industry standard Telnet software to view and edit entire Primary Network.
5. The primary network shall provide the following minimum performance:
   a. Provide high-speed data transfer rates for alarm reporting, report generation from multiple controllers and upload/download efficiency between network devices. System performance shall insure that an alarm occurring at any Building Controller is displayed at any PC workstations, all Building controllers, and other alarm printers within 15 seconds.
   b. Message and alarm buffering to prevent information from being lost.
   c. Error detection, correction, and re-transmission to guarantee data integrity.
   d. Synchronization of real-time clocks between Building Controllers, including automatic daylight savings time corrections.
   e. The primary network shall allow the Building Controllers to access any data from, or send control commands and alarm reports directly to, any other Building Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. Building Controllers shall send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device. The network shall also allow any Building controller to access, edit, modify, add, delete, back up, restore all system point database and all programs.
   f. The primary network shall allow the Building Controllers to assign password access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control only the points that the operator is authorized for. All other points shall not be displayed at the PC workstation or portable terminal. (e.g. all base building and all tenant points shall be accessible to any base building operators, but only certain base building and tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.
   g. Devices containing custom programming must reside on the Primary Network

F. Secondary Network – Application Specific Controller Communication:
   1. Communication over the secondary network can be the manufacturer's standard protocol
   2. Communication over the secondary network must allow BACnet MS/TP protocol.
   3. This level communication shall support a family of application specific controllers for terminal equipment.
   4. The Application Specific Controllers shall communicate bi-directionally with the primary network through Building Controllers for transmission of global data.

5. A maximum of 30 terminal equipment controllers may be configured on individual secondary network trunks to insure adequate global data and alarm response times.

2.4 OPERATOR INTERFACE:

A. Operator Interface Software:
   1. Basic Interface Description
      a. Operator interface software shall minimize operator training through the use of user-friendly and interactive graphical applications, 30-character English language point identification, on-line help, and industry standard Windows application software. Interface software shall simultaneously communicate with and share data between Ethernet-connected building level networks.
      b. Provide a graphical user interface that shall minimize the use of keyboard through the use of a mouse or similar pointing device, with a "point and click" approach to menu selection and a "drag and drop" approach to inter-application navigation.
      c. The navigation shall be user friendly by utilizing "forward & back" capability between screens and embedded hyperlinks to open graphics, documents, drawings, etc.
      d. Selection of applications within the operator interface software shall be via a graphical toolbar menu – the application toolbar menu shall have the option to be located in a docked position on any of the four sides of the visible desktop space on the workstation display monitor, and the option to automatically hide itself from the visible monitor workspace when not being actively manipulated by the user.
      e. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. BMS software shall run on a Windows XP, 2000, or comparable 32 bit operating system. System database parameters shall be stored within an object-oriented database. Standard Windows applications shall run simultaneously with the BMS software. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BMS alarms and monitoring information
      f. The software shall provide, as a minimum, the following functionality:
         1) Real-time graphical viewing and control of the BMS environment
         2) Reporting
         3) Scheduling and override of building operations
         4) Collection and analysis of historical data
         5) Point database editing, storage and downloading of controller databases.
         6) Utility for combining points into logical Point Groups. The Point Groups shall then be manipulated in Graphics, trend graphs and reports in order to streamline the navigation and usability of the system.
         7) Alarm reporting, routing, messaging, and acknowledgment
         8) "Collapsible tree," dynamic system architecture diagram application:
            a) Showing the real-time status and definition details of all workstations and devices on a management level network
            b) Showing the real-time status and definition details of all Building Controllers at the Primary Network.
            c) Showing the definition details of all application specific controllers
         9) Definition and construction of dynamic color graphic displays.

10) Online, context-sensitive help, including an index, glossary of terms, and the capability to search help via keyword or phrase.
11) On-screen access to User Documentation, via online help or PDF-format electronic file.
12) Automatic database backup at the operator interface for database changes initiated at Building Controllers.
13) Display dynamic trend data graphical plot.
    a) Must be able to run multiple plots simultaneously
    b) Each plot must be capable of supporting 10 pts/plot minimum
    c) Must be able to command points directly off dynamic trend plot application.
    d) Must be able to plot both real-time and historical trend data
14) Program editing
15) Transfer trend data to 3rd party spreadsheet software
    a) Scheduling reports
    b) Operator Activity Log
    c) Open communications via OPC Server
    d) Open communications via BACnet Client & Server

g. Enhanced Functionality:
    1) Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via adjustable user-sized windows. Operator shall be able to drag and drop information between the following applications, reducing the number of steps to perform a desired function (e.g., Click on a point on the alarm screen and drag it to the dynamic trend graph application to initiate a dynamic trend on the desired point):
        a) Dynamic color graphics application
        b) Alarm management application
        c) Scheduling application
        d) Dynamic trend graph data plotter application
        e) Dynamic system architecture diagram application
        f) Control Program and Point database editing applications
        g) Reporting applications
    2) Report and alarm printing shall be accomplished via Windows Print Manager, allowing use of network printers.

h. Security: Operator-specific password access protection shall be provided to allow the administrator/manager to limit users' workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges shall "follow" the operator to any workstation logged onto (up to 999 user accounts shall be supported). The administrator or manager shall be able to grant discrete levels of access and privileges, per user, for each point, graphic, report, schedule, and BMS workstation application. And each BMS workstation user account shall use a Windows Operating System user account as a foundation.

i. The operator interface software shall also include an application to track the actions of each individual operator, such as alarm acknowledgement, point commanding, schedule overriding, database editing, and logon/logoff. The application shall list each of the actions in a tabular format, and shall have sorting capabilities based on parameters such as ascending or descending time of the action, or name of the object on which the action was performed. The application shall also allow querying based on object name, operator, action, or time range.

j. Dynamic Color Graphics application shall include the following:
   1) Must include graphic editing and modifying capabilities
   2) A library of standard control application graphics and symbols must be included
   3) Must be able to command points directly off graphics application
   4) Graphic display shall include the ability to depict real-time point values dynamically with animation, picture/frame control, symbol association, or dynamic informational text-blocks
   5) Navigation through various graphic screens shall be optionally achieved through a hierarchical "tree" structure
   6) Graphics viewing shall include zoom capabilities
   7) Graphics shall be capable of displaying the status of points that have been overridden by a field HAND switch, for points that have been designed to provide a field HAND override capability.
   8) Advanced linking within the Graphics application shall provide the ability to navigate to outside documents (e.g., .doc, .pdf, .xls, etc.), Internet web addresses, e-mail, external programs, and other workstation applications, directly from the Graphics application window with a mouse-click on a customizable link symbol.

k. Reports shall be generated on demand or via pre-defined schedule, and directed to displays, printers or file. As a minimum, the system shall allow the user to easily obtain the following types of reports:
   1) A general listing of all or selected points in the network
   2) List of all points currently in alarm
   3) List of all points currently in override status
   4) List of all disabled points
   5) List of all points currently locked out
   6) List of user accounts and access levels
   7) List all weekly schedules and events
   8) List of holiday programming
   9) List of control limits and deadbands
   10) Custom reports from 3rd party software
   11) System diagnostic reports including, list of Building panels on line and communicating, status of all Building terminal unit device points
   12) List of programs
   13) List of point definitions
   14) List of logical point groups
   15) List of alarm strategy definitions
   16) List of Building Control panels
   17) Point totalization report
   18) Point Trend data listings
   19) Initial Values report
   20) User activity report

l. Scheduling and override
   1) Provide a calendar type format for simplification of time and date scheduling and overrides of building operations. Schedule definitions reside in the PC workstation and in the Building Controller to ensure time equipment scheduling when PC is off-line, PC is not required to execute time scheduling. Provide override access through menu selection, graphical mouse action or function key. Provide the following capabilities as a minimum:

a) Weekly schedules
b) Zone schedules
c) Event schedules – an event consists of logical combinations of equipment and/or zones
d) Report schedules
e) Ability to schedule for a minimum of up to ten (10) years in advance.

2) Additionally, the scheduling application shall:
a) Provide filtering capabilities of schedules, based on name, time, frequency, and schedule type (event, zone, report)
b) Provide sorting capabilities of schedules, based on name, time and type of schedule (zone, event, report)
c) Provide searching capabilities of schedules based on name – with wildcarding options

m. Collection and Analysis of Historical Data

1) Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals (up to four time-based definitions per point) or change of value, both of which shall be user-definable. Trend data shall be collected stored on hard disk for future diagnostics and reporting. Automatic Trend collection may be scheduled at regular intervals through the same scheduling interface as used for scheduling of zones, events, and reports. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.

2) Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of selected points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. BMS contractor shall provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. BMS contractor shall provide setup of custom reports including creation of data format templates for monthly or weekly reports.

3) Provide additional functionality that allows the user to view real-time trend data on trend graphical plot displays. A minimum of ten points may be plotted, of either real-time or historical data. The dynamic graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the display and take "snapshots" of plot screens to be stored on the workstation disk for future recall and analysis. Exact point values may be viewed and the graphs may be printed. A minimum of ten (10) dynamic graphs shall run simultaneously. Operator shall be able to command points directly on the trend plot by double clicking on the point. Operator shall be able to zoom in on a specific time range within a plot. The dynamic trend plotting application shall support the following types of graphs, with option to graph in 3D: line graph, area graph, curve graph, area-curve graph, step graph, and scatter graph. Each graph may be customized by the user, for graph type, graph text, titles, line styles and weight, colors, and configurable x- and y-axes.

n. Dynamic Color Graphic Displays

1) Capability to create color graphic floor plan displays and system schematics for each piece of mechanical equipment, including, but not limited to, air

handling units, chilled water systems, hot water boiler systems, and room level terminal units.

2) The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, point alarm association, or text-based commands. Graphics software shall permit the importing of AutoCAD or scanned pictures for use in the system.

3) Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations within the system schematics or graphic floor plan displays, and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.
   a) Provide the user the ability to display real-time point values by animated motion or custom picture control visual representation. Animation shall depict movement of mechanical equipment, or air or fluid flow. Picture Control shall depict various positions in relation to assigned point values or ranges. A library (set) of animation and picture control symbols shall be included within the operator interface software's graphics application. Animation shall reflect, ON or OFF conditions, and shall also be optionally configurable for up to five rates of animation speed.
   b) Sizable analog bars shall be available for monitor and control of analog values; high and low alarm limit settings shall be displayed on the analog scale. The user shall be able to "click and drag" the pointer to change the setpoint.
   c) Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.
   d) Equipment state or values can be changed by clicking on the associated point block or graphic symbol and selecting the new state (on/off) or setpoint.
   e) State text for digital points can be user-defined up to eight characters.

4) Colors shall be used to indicate status and change as the status of the equipment changes. The state colors shall be user definable.

5) Advanced linking within the Graphics application shall provide the ability to navigate to outside documents (e.g., .doc, .pdf, .xls, etc.), Internet web addresses, e-mail, external programs, and other workstation applications, directly from the Graphics application window with a mouse-click on a customizable link symbol.

6) The Windows environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

7) Off the shelf graphic software shall be provided to allow the user to add, modify or delete system graphic background displays.

8) A clipart library of HVAC application and automation symbols shall be provided including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams and laboratory symbols. The user shall have the ability to add custom symbols to the clipart library. The clipart library shall include a minimum of 400 application symbols. In addition, a library

consisting of a minimum of 700 graphic background templates shall be provided.

9) The Graphics application shall include a set of standard Terminal Equipment controller application-specific background graphic templates. Templates shall provide the automatic display of a selected Terminal Equipment controller's control values and parameters, without the need to create separate and individual graphic files for each controller.

o. System Configuration & Definition

1) A "Collapsible tree," dynamic system architecture diagram/display application of the site-specific BMS architecture showing status of controllers, PC workstations and networks shall be provided. This application shall include the ability to add and configure workstations, Building Controllers, as well as 3rd-party integrated components. Symbols/Icons representing the system architecture components shall be user-configurable and customizable, and a library of customized icons representing 3rd-party integration solutions shall be included. This application shall also include the functionality for real-time display, configuration and diagnostics connections to Building Controllers.

2) Network wide control strategies shall not be restricted to a single Building Controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.

3) Provide automatic backup and restore of all Building controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate Building Controller. Changes made at the user-interface of Building Controllers shall be automatically uploaded to the workstation, ensuring system continuity.

4) System configuration, programming, editing, graphics generation shall be performed on-line.

5) Point database configuration shall be available to the user within a dedicated point database editor application included in the operator interface software. The editor shall allow the user to create, view existing, modify, copy, and delete points from the database.

6) The point editor shall have the capability to assign "informational text" to points as necessary to provide critical information about the equipment.

7) The point editor shall also allow the user to configure the alarm management strategy for each point. The editor shall provide the option for editing the point database in an online or offline mode with the Building Controllers.

8) The operator interface software shall also provide the capability to perform bulk modification of point definition attributes to a single or multiple user-selected points. This function shall allow the user to choose the properties to copy from a selected point to another point or set of points. The selectable attributes shall include, but are not limited to, Alarm management definitions and Trend definitions.

9) Control program configuration shall be available to the user within a dedicated control program editor application included in the operator interface software. The editor shall allow for creation, modification and deletion of control programs. The editor shall include a programming assistance feature that interactively guides the user through parameters

required to generate a control program. The editor shall also include the ability to automatically compile the program to ensure its compatibility with the Building Controllers. The editor shall provide the option for editing the control programs in an online or offline mode, and also the ability to selectively enable or disable the live program execution within the Building Controllers.

p. Alarm Management
   1) Alarm Routing shall allow the user to send alarm notification to selected printers or workstation location(s) based on time of day, alarm severity, or point type.
   2) Alarm Notification shall be presented to each workstation in a tabular format application, and shall include the following information for each alarm point: name, value, alarm time & date, alarm status, priority, acknowledgement information, and alarm count. Each alarm point or priority shall have the ability to sound a discrete audible notification.
   3) Alarm Display shall have the ability to list & sort the alarms based on alarm status, point name, ascending or descending alarm time.
   4) Directly from the Alarm Display, the user shall have the ability to acknowledge, silence the alarm sound, print, or erase each alarm. The interface shall also have the option to inhibit the erasing of active acknowledged alarms, until they have returned to normal status. The user shall also have the ability to command, launch an associated graphic or trended graphical plot, or run a report on a selected alarm point directly on the Alarm Display.
   5) Each alarm point shall have a direct link from the Alarm Display to further user-defined point informational data. The user shall have the ability to also associate real-time electronic annotations or notes to each alarm.
   6) Alarm messages shall be customizable for each point, or each alarm priority level, to display detailed instructions to the user regarding actions to take in the event of an alarm. Alarm messages shall also have the optional ability to individually enunciate on the workstation display via a separate pop-up window, automatically being generated as the associated alarm condition occurs. The system shall have the ability to modify the priority text based on operator preference.
   7) Alarm Display application shall allow workstation operators to send and receive real-time messages to each other, for purposes of coordinating Alarm and BMS system management.

B. PORTABLE OPERATOR'S TERMINAL (POT)
   1. Provide Notebook style industry standard, commercially available portable operator terminals with a LCD display and a full-featured keyboard. When shown on contract drawings. The POT shall be handheld and plug directly into all Building Controllers as described below. Provide a user-friendly, English language-prompted interface for quick access to system information, not codes requiring look-up charts. Notebook selection shall be submitted to owner for review and approval based on current campus standards.
   2. Functionality of the portable operator's terminal connected at any Building Controller:
      a. Access all Building Controllers and Application Specific Controllers (ASCs) on the network.
      b. Backup and/or restore Building Controller data bases for all system panels, not just the Building Controller connected to.
      c. Display all point, selected point and alarm point summaries.

d. Display trending and totalization information.
e. Add, modify and/or delete any existing or new system point.
f. Command, change, and enable/disable any system point.
g. Program and load custom control sequences as well as standard energy management programs.
h. Acknowledge alarms

3. Functionality of the portable operator's terminal connected to any application specific controller:
   a. Provide connection capability at either the Floor Level Network Controller or a related room sensor to access controller information.
   b. Provide status, setup and control reports.
   c. Modify, select and store controller data base.
   d. Command, change, and enable/disable any controller point.
4. Connection of a POT to a Building or ASC Controller shall not interrupt nor interfere with normal network operation in any way, prevent alarms from being transmitted or preclude centrally-initiated commands and system modification.
5. Portable operator terminal access to controller shall be password-controlled. Password protection shall be configurable for each operator based on function, points (designating areas of the facility), and edit/view capability.

2.5 BUILDING CONTROLLER SOFTWARE

A. General:
1. Furnish the following applications software to form a complete operating system for building and energy management as described in this specification.
2. The software programs specified in this Section shall be provided as an integral part of Building Controllers and shall not be dependent upon any higher level computer or another controller for execution.
3. All points, panels and programs shall be identified by a 30 character name. All points shall also be identified by a 16 character point descriptor. The same names shall be displayed at both Building Controller and the Operator Interface.
4. All digital points shall have a user defined two-state status indication with 8 characters minimum (e.g. Summer, Enabled, Disabled, Abnormal).
5. The Building Controller Software shall be capable of BACnet communications. The BACnet Building Controller (B-BC) shall have demonstrated interoperability during at least one BTL Interoperability Workshop and shall substantially conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, Annex L.
6. Building Controllers shall have the ability to perform energy management routines including but not limited to time of day scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, start stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating / cooling interlock, supply temperature reset, priority load shedding, and power failure restart.
7. The Building Controllers shall have the ability to perform the following pre tested control algorithms:
   a. Two position control
   b. Proportional control
   c. Proportional plus integral control
   d. Proportional, integral, plus derivative control

e. Automatic tuning of control loops
f. Model-Free Adaptive Control

8. Each controller shall be provided with an interactive HELP function to assist operators using POTs and remote connected operators.
9. Building Controllers shall not be susceptible` to Microsoft Windows operating systems based viruses.

B. System Security
1. User access shall be secured using individual security passwords and user names.
2. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
3. User Log On / Log Off attempts shall be recorded.
4. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
5. Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the field panel.

C. User Defined Control Applications:
1. Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
2. It shall be possible to use any system measured point data or status, any system calculated data, a result from any process, or any user-defined constant in any controller in the system.
3. Any process shall be able to issue commands to points in any and all other controllers in the system.
4. Processes shall be able to generate operator messages and advisories to other operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
5. Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.
6. Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task oriented information from the user manual.

D. Alarm Management:
1. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each Building Controller shall perform distributed, independent alarm analysis, minimize network traffic and prevent alarms from being lost. At no time shall the Building Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
2. Conditional alarming shall allow generation of alarms based upon user defined multiple criteria.
3. An Alarm "shelving" feature shall be provided to disable alarms during testing. (Pull the Plug, etc.).
4. Binary Alarms. Each binary object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
5. Analog Alarms. Each analog object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.
6. All alarm or point change reports shall include the point's user defined language description and the time and date of occurrence.

7. Alarm reports and messages shall be routed to user-defined list of operator workstations, or other devices based on time and other conditions. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display graphics.
8. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
9. Each Building Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assignable to any number of points in the Controller.

E. Scheduling:
1. Provide a comprehensive menu driven program to automatically start and stop designated multiple objects or events in the system according to a stored time.
2. Schedules shall reside in the building controller and shall not rely on external processing or network.
3. It shall be possible to define a group of objects as a custom event (i.e. meeting, athletic activity, etc.). Events can then be scheduled to operate all necessary equipment automatically.
4. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start and/or stop within that group.
5. The operator shall be able to define the following information:
   a. Time, day
   b. Commands such as on, off, auto, etc.
   c. Time delays between successive commands.
   d. There shall be provisions for manual overriding of each schedule by an authorized operator.
6. It shall be possible to schedule calendar-based events up to one year in advance based on the following:
   a. Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. When a group of objects are scheduled together as an Event, provide the capability to adjust the start and stop times for each member.
   b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.

F. Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.

G. Night setback control. The system shall provide the ability to automatically adjust setpoints for night control.

H. Loop Control. A Model-Free Adaptive Control algorithm or alternatively a PID (proportional-integral-derivative) closed-loop control algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, set point, and weighting parameters shall be user-selectable.

I. Sequencing. Provide application software based upon the sequences of operation specified to properly sequence equipment.

J. Staggered Start:
   1. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable.
   2. Upon the resumption of power, each Building Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

K. Totalization:
   1. Run-Time Totalization. Building Controllers shall automatically accumulate and store run-time hours for all digital input and output points. A high runtime alarm shall be assigned, if required, by the operator.
   2. Consumption totalization. Building Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.
   3. Event totalization. Building Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for all points. The event totalization feature shall be able to store the records associated with events before reset.

L. Data Collection:

   1. A variety of historical data collection utilities shall be provided to manually or automatically sample, store, and display system data for all points.
   2. Building Controllers shall store point history data for selected analog and digital inputs and outputs:
      a. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each Building Controllers point group.
   3. Trend data shall be stored at the Building Controllers and uploaded to the workstation when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in 3rd party personal computer applications.
   4. Loop Tuning. Building Controllers shall also provide high resolution sampling capability for verification of DDC control loop performance. Documented evidence of tuned control loop performance shall be provided on a seasonal basis, at the beginning of the heating season in the Fall, and at the beginning of the cooling season in the Spring.
      a. For Model-Free Adaptive Control loops, evidence of tuned control loop performance shall be provided via graphical plots or trended data logs. Graphical plots shall minimally include depictions of setpoint, process variable (output), and control variable (e.g., temperature). Other parameters that may influence loop control shall also be included in the plot (e.g., fan on/off, mixed-air temp).
      b. For PID control loops, operator-initiated automatic and manual loop tuning algorithms shall be provided for all operator-selected PID control loops. Evidence of tuned control loop performance shall be provided via graphical plots or trended data logs for all loops.
         1) In automatic mode, the controller shall perform a step response test with a minimum one-second resolution, evaluate the trend data, calculate the new PID gains and input these values into the selected LOOP statement.
         2) Loop tuning shall be capable of being initiated either locally at the Building Controller, from a network workstation or remotely using dial-in modems.

For all loop tuning functions, access shall be limited to authorized personnel through password protection.

2.6 BUILDING CONTROLLERS

A. Building Controllers shall be 32 bit, multi-tasking, multi-user, real-time 48 MHz digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.

B. Each Building Controller shall support a minimum of 3 directly connected Secondary Networks.

C. Each Building Controller shall have sufficient memory, a minimum of 72 megabyte, to support its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, and dial-up communications.

D. Building Controller shall have an integral real-time clock.

E. Each Building Controller shall support firmware upgrades without the need to change hardware.

F. Each Building Controller shall support:
1. Monitoring of industry standard analog and digital inputs, without the addition of equipment outside the Building Controller cabinet.
2. Monitoring of industry standard analog and digital outputs, without the addition of equipment outside the Building Controller cabinet.

G. Spare Point Capacity. Each Building Controller shall have a minimum of 10 percent spare point capacity.
1. The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than one spare of each implemented I/O type.
2. Provide all processors, power supplies, and communication controllers so that the implementation of adding a point to the spare point location only requires the addition of the appropriate:
3. Expansion modules
4. Sensor/actuator
5. Field wiring/tubing.
6.

H. Serial Communication. Building Controllers shall provide at least two EIA-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals. Building Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected printers or terminals.

I. Manual Override. The operator shall have the ability to manually override automatic or centrally executed commands at the Building Controller via local, point discrete, integral hand/off/auto operator override switches for all digital control type points and gradual switches for all analog control type points. These override switches shall be operable whether the panel

processor is operational or not. Each Building Controller shall monitor and alarm the hand, off and auto positions of integral HOA switches.

J. I/O Status and Indication. Building Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. All wiring connections shall be made to field-removable terminals.

K. Self Diagnostics. Each Building Controller shall continuously perform self diagnostics, communication diagnosis, and diagnosis of all panel components. The Building Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication for any system.

L. Power loss. In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 100 hours.

M. Environment.
1. Controller hardware shall be suitable for the anticipated ambient conditions.
2. Controllers used outdoors and/or in wet ambient conditions shall be mounted within weather proof NEMA 4 enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
3. Controllers used in conditioned space shall be mounted in dust-proof NEMA 12 enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).

N. Immunity to power and noise.
1. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
3. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
   a. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
   b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
   c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
   d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)
4. Isolation shall be provided at all Building Controller's AC input terminals to suppress induced voltage transients consistent with:
   a. IEEE Standard 587 1980
   b. UL 864 Supply Line Transients
   c. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

O. Minimum Approved Building Controllers. BMS Contractors shall furnish Building Controllers as listed below. Providing an approved controller does not release the contractor from meeting all performance, software and hardware specifications for Building Controllers and system operations.
1. Delta Controls DSC/DAC Modular Building/Equipment Controllers.

2.7 APPLICATION SPECIFIC CONTROLLERS (ASC)

A. General:

1. Provide for control of each piece of equipment , including, but not limited to the following:
   a. Variable Air Volume (VAV) boxes
   b. Reheat Coils (RH)
   c. Unit Conditioners
   d. Heat Pumps
   e. Exhaust Fans
   f. Air handling units
2. Each Building Controller shall be able to communicate with application specific controllers (ASCs) over the Secondary Network to control terminal equipment only.
3. The use of Secondary Network controllers with custom program applications to control AHU's, water systems, etc. is not acceptable.
4. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.
5. Each ASC shall include all point inputs and outputs necessary to perform the specified control sequences. The ASC shall accept input and provide output signals that comply with industry standards. Controllers utilizing proprietary control signals shall not be acceptable. Outputs utilized either for two-state, modulating floating, or proportional control, allowing for additional system flexibility.
6. Space Temperature Sensors. Each controller performing space temperature control shall be provided with a matching room temperature sensor. For private offices and conference rooms, space temperature sensors shall be user adjustable, with temperature and setpoint indication. For classrooms, laboratories, corridors, and other public spaces, space temperature sensors shall be non-adjustable with tamper proof cover. All conditioned spaces other than corridors shall be provided with an occupancy override switch for after hours operation.
   a. Wired Sensor specifications. The sensor may be either RTD or thermistor type providing the following.
      1) Accuracy: + .36 F
      2) Operating Range: 35 to 115 F
      3) Set Point Adjustment Range: 55 to 95 F
      4) Calibration Adjustments: None required
      5) Installation: Up to 100 ft. from controller
      6) Auxiliary Communications Port:
      7) Local LCD Temperature Display: as required
      8) Set Point Adjustment Dial as required
      9) Occupancy Override Switch as required
   b. Set Point Modes:
      1) Independent Heating, Cooling
      2) Night Setback-Heating
      3) Night Setback-Cooling
   c. Auxiliary Communication Port. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator's terminal.

d. Set Point Adjustment Dial. The set point adjustment dial shall allow for modification of the temperature by the building operators. Set point adjustment may be locked out, overridden, or limited as to time or temperature through software by an authorized operator at any central workstation, Building Controller, room sensor two-line display, or via the portable operator's terminal.

e. Override Switch. An override switch shall initiate override of the night setback mode to normal (day) operation when activated by the occupant and enabled by building operators. The override shall be limited to two (2) hours (adjustable.) The override function may be locked out, overridden, or limited through software by an authorized operator at the operator interface, Building Controller, room sensor two-line display or via the portable operator's terminal.

7. Communication. Each controller shall perform its primary control function independent of other Secondary Network communication, or if Secondary Network communication is interrupted. Reversion to a fail-safe mode of operation during Secondary Network interruption is not acceptable.

8. Control Algorithms. The controller shall receive its real-time data from the Building Controller time clock to insure Secondary Network continuity. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via room sensor LCD or the portable operator's terminal as specified herein. Controllers that incorporate proportional and integral (PI) control algorithms only shall not be acceptable.

9. Control Applications. Operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.

10. Calibration. Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time.

    a. Manual calibration may be accomplished by either commanding the actuator to 0% via the POT or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary

    b. Calibration shall be accomplished by stroking the terminal unit damper actuator to a 0% position so that a 0 CFM air volume reading is sensed. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa.

    c. Calibration shall be accomplished by zeroing out the pressure sensor and holding damper at last known position until calibration is complete. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa.

11. Memory.

    a. Provide each ASC with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM, or minimum of 72-hour battery backup shall be provided. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.

    b. Upon replacement, new ASCs shall recover control function and site specific defaults automatically and resume normal operation.

12. Power Supply. The ASCs shall be powered from a 24 VAC source and shall function normally under an operating range of 18 to 28 VAC, allowing for power source fluctuations and voltage drops. Power supply for the ASC must be rated at a minimum of

125% of ASC power consumption and shall be of the fused or current limiting type. The BMS contractor shall provide 24 VAC power to the terminal units by utilizing:

a. The existing line voltage power trunk and installing separate isolation transformers for each controller
b. Dedicated line voltage power source and isolation transformers at a central location and installing 24VAC power trunk to supply multiple ASCs in the area.

13. Environment. The controllers shall function normally under ambient conditions of 32 to 122 F (0 to 50 C) and 10% to 95%RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the circuit board assembly.
14. Immunity to noise. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
15. Manufacturer Installed Controls.
    a. BMS manufacturer shall furnish ASC and actuator for factory mounting to equipment manufacturer.
    b. Cost of factory mounting shall be borne by equipment manufacturer.
    c. For VAV terminals, equipment manufacturer shall provide and install flow-cross sensor, 24 Vac transformer, controls enclosure, fan relay, SCR and factory install, wire and tube the ASC controller and actuator provided by Delta.

B. Controllers for VAV terminals.
1. All VAV terminal control applications shall be field-selectable such that a single controller may be used in conjunction with any of the above types of terminal units to perform the specified sequences of control. ASC's that require factory application changes are not acceptable. The VAV terminal ASC shall support the following types of pressure independent terminal boxes as a minimum:
    a. VAV cooling only
    b. VAV with hot water
2. The controller shall include a differential pressure transducer that shall connect to the terminal unit manufacturer's standard averaging air velocity sensor to measure the average differential pressure in the duct. The controller shall convert this value to actual air flow. Single point air velocity sensing is not acceptable. The differential pressure transducer shall have a measurement range of 0 to 4000 fpm (0 to 20.4 m/s) and measurement accuracy of +5% at 400 to 4000 fpm (2 to 20 m/s), insuring primary air flow conditions shall be controlled and maintained to within +5% of set point at the specified parameters. The BMS contractor shall provide the velocity sensor if required to meet the specified functionality.

2.8 INPUT/OUTPUT INTERFACE:

A. Hardwired inputs and outputs may tie into the system through building or application specific controllers.

B. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to the controller.

C. Binary inputs shall allow the monitoring of On/Off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise.

Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.

D. Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.

E. Analog inputs shall allow the monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with—and field configurable to— commonly available sensing devices.

F. Binary outputs shall provide for On/Off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers shall have three-position (On/Off/Auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.

G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC, 4 to 20 mA or 0-20 PSI signal as required to provide proper control of the output device. Analog outputs on building or custom application controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.

H. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation, etc.). Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

I. System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.9 POWER SUPPLIES AND LINE FILTERING

A. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

B. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure.
   1. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
   2. Line voltage units shall be UL recognized and CSA approved.

C. Power line filtering.
1. Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:
a. Dielectric strength of 1000 volts minimum
b. Response time of 10 nanoseconds or less
c. Transverse mode noise attenuation of 65 dB or greater
d. Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.

2.10 AUXILIARY CONTROL DEVICES

A. GENERAL
1. Specified in this section are the following hard wired input/output devices connected to the Building Controller or ASC. Devices only required if specified by points list, control diagram or sequence of operation.
a. Electric Damper Actuators
b. Motorized Isolation Valves
c. Ball Valves
d. Automatic Control Valves
e. Airflow Measuring Stations
f. Binary Temperature Devices
g. Temperature Sensors
h. Dew Point/Humidity Sensors
i. Pressure Sensors
j. Water Differential Pressure Sensors
k. Differential Pressure Switches
l. Analog Water Level Sensors
m. Water Leak Detection Systems
n. Audio/Visual Alarm Units
o. Fuel Oil Meters
p. Water BTU Meters
q. Ultrasonic Flow Meters
r. Indoor Air Quality (CO2/VOC) Space Sensors
s. Relays
t. Override Timers
u. Current Transformers
v. Voltage Transmitters
w. Voltage Transformers
x. Power Monitors
y. Current Switches
z. Pressure Electric Switches
aa. Electro-pneumatic Transducers
bb. Local Control panels
cc. Local User Display

B. Electric Damper Actuators (For AHU-1 & 2)
1. General
a. The actuator shall have mechanical or electronic stall protection to prevent damage to the actuator throughout the rotation of the actuator.

b. Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing. Alternatively, an uninterruptible power supply (UPS) may be provided. On terminal unit valves actuators capacitor driven fail action is permitted.
c. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.
d. All 24 VAC/VDC actuators shall operate on Class 2 wiring.
e. All actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 Nm (60 in.-lb) torque capacity shall have a manual crank for this purpose.
f. Electric actuators for emergency generator damper control shall be rated for 350 degree F. maximum operating temperature and capable to drive fully open and close within 15 seconds.

C. MOTORIZED ISOLATION VALVES
1. Butterfly Valves. (For AHU-1 & AHU-2 Chilled Water Coils)
a. Furnish automatic butterfly valves for isolation requirements as shown on the drawings or required herein. All butterfly valves shall have body ratings in accordance with the piping specifications. Valves shall be high performance, fully lugged with carbon steel body ANSI 150/300. Valves shall be rated for bubble tight dead-end closure, with 316 stainless steel disc, stainless steel shaft and reinforced Teflon seat and seals.
b. Motorized valves located outdoors or in areas subject to outdoor air conditions provide fail in place, electric operators with water proof enclosure, crankcase heater, and open and closed position limit switches. Valve and all accessories shall be constructed for outdoor use. All electrical devices shall be weather proof and NEMA 4 rated.
c. All valves shall be provided with external position indicators and a speed control device to prevent to rapid closure.
d. All valves shall be provided with manual override hand wheels for operating the valve.
e. The valves shall be line size as shown on plans.
f. Motorized isolation valves shall be Belimo, Keystone, Bray, Jamesbury 815/830L, Fisher, or DeZurik Model HP II.

D. AUTOMATIC BALL VALVES. (For AHU-1 & 2 Heating Hot Water Coils)
1. Furnish automatic full port ball valves for isolation requirements on line sizes up to 2'as shown on the drawings or required herein. All ball valves shall have ANSI 250 body rating. Valves shall bronze body and stainless-steel trim.
2. Valves shall close against a differential pressure equal to the design pump head pressure plus 10%.
3. The valves shall fail to their safe position upon power loss as specified in the sequence of operation.
4. All valves shall be provided with manual override.
5. Provide valve position indicator end switches with the actuator.
6. The valves shall be line size as shown on plans.
7. Motorized isolation valves shall be Siemens, Belimo, Dezurik or Neptronic.

E. AUTOMATIC CONTROL VALVES. (For VAV box Reheat Coils)
1. General:

a. Control valves shall be two-way or three-way type single seated globe type for two-position or modulating service as shown. Valves shall meet ANSI Class IV leakage rating.
b. Body pressure rating and connection type construction shall conform to pipe, fitting and valve schedules. Where pressure and flow combinations exceed ratings for commercial valves and operators, industrial class valves and operators shall be provided.
c. Valve operators shall be of pneumatic or electric type.
d. The valves shall be quiet in operation and fail-safe in either normally open or normally closed position in the event of power failure.
e. Control valve operators shall be sized to close against a differential pressure equal to the design pump head plus 10 percent.
f. Furnish differential pressure control valves for all water systems as shown on plans and/or specified in the sequence of operations.
g. Provide valves 2" and smaller with screwed end bronze bodies and stainless steel trim. Provide valves 2-1/2" and larger with flanged ends, cast iron body and stainless steel trim.
h. For modulating service that require large valve size (above 6"), such as cooling tower temperature bypass, chiller head pressure ,etc. where proper control with globe type control valve cannot be achieved or the application is not economical butterfly or v-port ball valves are allowed.

2. Water Valves:
   a. Control valves shall be of equal percentage flow characteristics for modulating service.
3. Steam Valves:
   a. Control valves shall be of linear flow characteristics for modulating service.

F. AIR FLOW MEASURING STATIONS (AMS - As indicated on Control Diagram on plans)
1. Fan Inlet Type:
   a. Air Handling Unit Manufacturer to provide airflow measuring stations where shown on the fan inlet. Fan Inlet flow stations will be provided with the air handling unit or fan manufacturer. See Spec Section 237416 Custom Air handling units. Fan airflow measurement shall be calculated via differential pressure between piezometric ring measurement around fan inlet and discharge plenum.
   b. Probes shall be capable of operating with an accuracy of 3% of actual volume over the fan operating range. A 4-20mA control signal with a linear out put reading the fan CFM shall be provided.
2. Outside Air Type:
   a. Contractor to provide where indicated on the plans. Outside air applications will use the thermal dispersion airflow measurement flow stations for accurate flow at low air velocity. Linear 4-20mA flow transmitter will be used for inputting probes and transmitting air flow. Ebtron P series with Silver series transmitter or equal.

G. BINARY TEMPERATURE DEVICES (As indicated on Control Diagram on plans)
1. Line-voltage space thermostat:
   a. Line-voltage thermostats shall be bimetal-actuated, snap acting SPDT contact, enclosed, UL listed for electrical rating. The thermostat cover shall provide exposed set point adjustment knob. The thermostat shall operate within the 55°F to 85°F setpoint range, with 2°F maximum differential.
2. Low-temperature safety thermostat:

a. Low-limit air stream thermostats shall be UL listed, vapor pressure type, with a sensing element of 20 ft. minimum length. Element shall respond to the lowest temperature sensed by any 1 ft. section. The low-limit thermostat shall be automatic reset, SPDT type.

3. Aquastat:
   a. Strap-on type thermostats shall be provided for low or high temperature limit service on hot water or steam condensate pipes. The thermostats shall be UL listed, with a liquid-filled bulb type sensing element and capillary tubing. The thermostat shall operate within the 20°F to 120°F, or 100°F to 240°F, setpoint range, with an adjustable 6°F differential.
   b. The low-limit thermostat shall be automatic reset, snap acting SPDT type with concealed set point adjustment.

H. TEMPERATURE SENSORS. (T - As indicated on the mechanical floor plans)

1. Provide the following instrumentation as required by the monitoring, control and optimization functions. All temperature sensors shall use platinum RTD elements only, nickel or silicon are not acceptable. All control signals shall be via a 4-20 mA loop. Where platinum RTD temperature sensors are available, thermistors shall not be used.
2. Room Temperature:

a.	Temperature monitoring range	+20/+120 F or +40/+90 F
b.	Output signal	4-20 mA
c.	Installation adjustments	none required
d.	Element	Platinum
e.	Factory calibration point	77 deg F
f.	Accuracy at calibration point	+0.36 deg F at 77F

3. Liquid Immersion Temperature

a.	Temperature monitoring range	+30/+250 F
a.	Output signal	4-20 mA
b.	Installation adjustments	none required
c.	Element	Platinum
d.	Factory calibration point	32 deg F
e.	Accuracy at calibration point	+0.36 deg F at 32F

4. Duct (Single Point) Temperature

a.	Temperature monitoring range	20/+120 F
b.	Output signal	4-20 mA
c.	Installation adjustments	none required
d.	Element	Platinum
e.	Factory calibration point	32 deg F
f.	Accuracy at calibration point	+0.36 deg F at 32F

5. Duct (Averaging) Temperature

a.	Temperature monitoring range	20/+120 F
b.	Output signal	4-20 mA
c.	Installation adjustments	none required
d.	Element	Platinum
e.	Factory calibration point	32 deg F
f.	Accuracy at calibration point	+0.36 deg F at 32F

6. Outside Air Temperature

a.	Temperature monitoring range	-58/+122 F
b.	Output signal	4-20 mA
c.	Installation adjustments	none required
d.	Element	Platinum

e. Factory calibration point 32 deg F
f. Accuracy at calibration point +0.36 deg F at 32F

I. DEW POINT/HUMIDITY SENSORS (HS - As indicated on Control Diagram on plans)
1. Outside Air Dew Point Temperature
a. Dew point monitoring range -40/+115 F DP, 12% to 99% RH
b. Output signal 4-20 mA
c. Calibration adjustments zero & span
d. Factory calibration point 70 F
e. Accuracy at calibration point +2.0 Fdp
2. Room/duct Relative Humidity
a. Sensor Humidity range 0 to 100%
b. Operating temperature 15 F to +170 F
c. Accuracy +2% RH
d. Sensing element Capacitive sensor
e. Output signal 4-20 mA DC
f. Installation adjustments zero & span
g. Operating temperature 15 F to +170 F
h. Voltage requirement 12-36 VDC

J. AIR DIFFERNTAIL PRESSURE SENSORS (DPS - As indicated on Control Diagram on plans)
1. Air Static Pressure Sensor
a. Duct Static range -.5 to + 7.5"wg
b. Accuracy + .05" w.g.
c. Output signal 4 - 20 mA
d. Actual sensor used will be sized for its application so that it is accurate in the range it will be reading. (e.g. room -0.5- +0.5, fan static pressure 0-5.0", etc.)

K. WATER DIFFERENTIAL PRESSURE SENSOR (DPS indicated on Control Diagram on plans)
1. Transducer shall have linear output signal. Zero and span shall be field adjustable.
2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure up to 250 psig without damage.
3. Water pressure transducer shall have stainless steel diaphragm construction with elastomer seals. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and block and bleed valves.
4. Provide NEMA 4 construction differential pressure sensors for all differential pressure sensors and bypass valves. Sensor shall be factory calibrated for operating range and rated for system pressure. Constructed of 316L Stainless steel. Provide manufacturers standard 3 valve manifold. Output shall be 4-20 ma. Sensor shall be Rosemount model 1151 with 3 port manifold Model 0305 or approved equal.

L. DIFFERENTIAL PRESSURE SWITCHES. (PS - As indicated on Control Diagram on plans)
1. Water Differential Pressure Switch
a. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 12 enclosure, with scale range and differential suitable for intended application or as shown.
b. The differential switches shall meet the following requirements:
1) Range 8 to 70 psi
2) Differential 3 psi

3) Maximum differential pressure 200 psi
4) Maximum pressure 325 psi

2. Air Differential Pressure Switch
   a. Differential pressure switches shall be diaphragm type, with die-cast aluminum housing and adjustable set point. Switch rating shall be a minimum 5 amps at 120 VAC. Switches shall be SPDT and be used for fan status if specified in the point schedule. Switch pressure range shall be suited for application. (e.g. filter 0-2.0", fan status 0-5.0", etc.)
   b. Differential pressure switches used for duct high static pressure shall be the manual reset type to avoid fan cycling in an over pressure situation.

M. BTU Meters (As indicated on Control Diagram on plans)
1. Provide Onicon F-3100 Inline Magmeter Flow Sensor with System 10 BTU Interface including matched temperature sensors. Integration shall be through bacnet. See Mechanical Drawings for location and sizes.
   a. General Water Flow Meter
   b. Operating Range: 0.033 to 33 ft/s
   c. Pipe Size Range: 1 in. to 48 in.
   d. Accuracy: ±0.2% of reading from 1.6 to 33 ft/s, +/- 0.0033 ft/s from 0.033 to 1.6 ft/s
   e. Minimum Conductivity: 5 µS/cm
   f. Class 150 flanges.
   g. Flow tube shall be epoxy coated steel and the sensing electrodes shall be 316 stainless steel.
2. Display/Controller/Temperature Sensors
   a. Provide Onicon System-10 or approved equal.
   b. Shall provide the following points both at the integral LCD and as outputs to the BMS:
      1) Energy Total
      2) Energy Rate
      3) Flow Rate
      4) Supply and Return Temperatures
   c. Provide BacNet interface.
   d. Output shall be either serial network (compliant with the BMS system) or via individual analog and pulse outputs.
   e. Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath calibrated and matched (NIST traceable). Sensors shall be matched to an accuracy better than ± 0.15°F
   f. Meter shall be provided per section above.
   g. Meter shall be re-programmable using the front panel keypad.
3. Max. Temperature/Pressure Rating
   a. Storage Temperature: -4 °F to 158 °F
   b. Relative Humidity: 0 to 95% (non-condensing)
   c. Operating Temperature: Ambient: 14 °F to 158 °F, Media: 32 °F to 185 °F
   d. Maximum Operating Pressure: 150 psi @ 77 °F
4. Standards and Approvals
   a. NEMA 4X / IP65 Enclosure (with cap installed)

N. INDOOR AIR QUALITY (CO2/VOC) SENSORS (As indicated on mechanical floor)
1. Provide indoor air quality sensors to monitor Carbon Dioxide (CO2) and Volatile Organic Compound (VOC) levels.

2. The sensors shall be of microprocessor-based photoacoustic type with heated stannic dioxide semiconductor.
3. The CO2 sensors shall have no more than 1% drift during the first year of operation and minimal drift thereafter so that no calibration will be required.
4. The units shall be wall or duct mounted type as indicated on plans and in the sequence of operation.
5. Wall mounted sensors shall be provided with white plastic cover, without LED indicators.
6. Duct mounted sensors shall be provided with LED indicators in a dust proof plastic housing with transparent cover.
7. The VOC sensor shall have automatic self calibrating capability to ensure accuracy.
8. The sensor shall meet the following requirements:

a.	Operating voltage:	24 VAC +/- 20%
b.	Frequency:	50/60 Hz
c.	Power consumption:	max. 6 VA
d.	CO2 measuring range:	0 – 2000 ppm
e.	Tolerance:	+/- 100 ppm
f.	Output:	0 – 10 VAC
g.	Calibration:	none required
h.	VOC measurement range:	0 – 10 V VOC
i.	Permissible air velocity in duct:	<26.2 Ft/s.

O. RELAYS.
1. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable ±200% (minimum) from set point shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 12 enclosure when not installed in local control panel.

P. OVERRIDE TIMERS. (where specified in points list)
1. Override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration as required by application. Provide 0-to-6-hour calibrated dial unless otherwise specified. Timer shall be suitable for flush mounting on control panel face and located on local control panels or where shown.

Q. CURRENT TRANSMITTERS. (As indicated on Control Diagram on plans)
1. AC current transmitters shall be the self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale, with internal zero and span adjustment and ±1% full-scale accuracy 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.

R. CURRENT TRANSFORMERS. (As indicated on Control Diagram on plans)
1. AC current transformers shall be UL/CSA Recognized and 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. Transformers shall be fixed-core or split-core type for installation on new or existing wiring, respectively.

S. POWER MONITORS. (where specified in points list)
1. Power monitors shall be the three-phase type furnished with three-phase disconnect/shorting switch assembly, UL Listed voltage transformers, and UL Listed split-core current transformers.
2. They shall provide a selectable rate pulse output for kWh reading and a 4 to 20 mA output for kW reading. They shall operate with 5 A current inputs with a maximum error of ±2% at 1.0 power factor or ±2.5% at 0.5 power factor.

T. LOCAL CONTROL PANELS.
1. All indoor control cabinets shall be fully enclosed NEMA 12 construction with (hinged door) key-lock latch and removable sub panels. A single key shall be common to all field panels and sub panels.
2. Interconnections between internal and face mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.11 COMMUNICATION AND CONTROL WIRING

A. General:
1. Provide copper wiring, plenum cable, and raceways as specified in the Division 26 - Electrical unless otherwise noted.
1. All insulated wire to be copper conductors, UL labeled for 90°C minimum service.

B. Wire Sizing and Insulation
1. Wiring shall comply with minimum wire size and insulation based on services listed below:

	Service	Minimum Gage/Type	Insulation Class
a.	Service	Minimum Gage/Type	Insulation Class
b.	AC 24V Power	12 Ga Solid	600 Volt
c.	DC 24V Power	10 Ga Solid	600 Volt
d.	Class 1	14 Ga Stranded	600 Volt
e.	Class 2	18 Ga Stranded	300 Volt
f.	Class 3	18 Ga Stranded	300 Volt

2. Provide plenum-rated cable when open cable is permitted in supply or return air plenum where allowed per execution specifications defined in Paragraph 3.07

C. Control Wiring:
1. Digital Input/Output wiring shall use Class 2 twisted pair, insulated.
2. Analog inputs shall use Class 2 twisted shielded pair, insulated and jacketed and require a grounded shield.
3. Actuators with tri-state control shall use 3 conductor with same characteristics

D. Communication Wiring

1. Ethernet Cable shall be minimum CAT5
2. Secondary level network shall be 24 gage, TSP, low capacitance cable

E. Approved Cable Manufacturers:
1. Wiring from the following manufacturers which meet the above criteria shall be acceptable:
   a. Anixter
   b. Belden

PART 3 - EXECUTION

3.1 EXAMINATION:

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.

B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started..

3.2 PROTECTION:

A. The contractor shall protect all work and material from damage by its employees and/or subcontractors and shall be liable for all damage thus caused.

B. The contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted.

3.3 COORDINATION:

A. Site
1. The project coordination between trades is the responsibility of the prime contractor who is the one tier higher contractual partner such as mechanical contractor, general contractor, construction manager, owner or owner's representative as applicable.
2. The controls contractor shall follow prime contractor's job schedule and coordinate all project related activities through the prime contactor except otherwise agreed or in minor job site issues. Reasonable judgment shall be applied.
3. Where the work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment.
4. If the contractor deviates form the job schedule and installs work without coordinating with other trades, so as to cause interference with work of other trades, the contractor shall make the necessary changes to correct the condition without extra charge.
5. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

B. Submittals.
   1. Refer to the "Submittals" article in Part 1 of this specification for requirements.

C. Test and Balance
   1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.

D. Life Safety
   1. Duct smoke detectors required for air handler shutdown are supplied under Section 28 31 00 – Fire Detection and Alarm . That contractor shall interlock smoke detectors to air handlers for shutdown as described in Part 3, "Sequences of Operation." That contractor will also provide auxiliary contacts for when necessary to monitor fire alarm status.
   2. Fire/smoke dampers and actuators required for fire rated walls are provided under Division 23 – Heating, Ventilating and Air Conditioning. For control and interlock of these dampers refer to Section 28 31 00 – Fire Detection and Alarm.

E. Coordination with controls specified in other sections or divisions.
   1. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:
      a. All communication media and equipment shall be provided as specified in Part 2, "Communication" of this specification.
      b. Each supplier of controls product is responsible for the configuration, programming, startup, and testing of that product to meet the sequences of operation described in this section. This contractor will monitor and adjust their parameters only through the system specified here.
      c. The Contractor shall coordinate and identify any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.
      d. Each supplier of controls product is responsible for providing software database for properly configuring the communications to that system 8 weeks prior to scheduled start-up. Contractor will notify all appropriate parallel contractors of this need.
      e. The contractor is responsible for the interface of control products provided by multiple suppliers when the supplier has a BacNet or another acceptable open protocol device. Systems to be integrated will be shown on the drawings, points list, control details or sequence of operation.

3.4 GENERAL WORKMANSHIP:

A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).

D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 FIELD QUALITY CONTROL:

A. Contractor shall have a quality manager on staff to inspect the project execution and to enforce quality standards.

B. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification.

C. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.

D. Contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.

3.6 WIRING:

A. All control and interlock wiring shall comply with national and local electrical codes and Division 26 – Electrical of this specification. Where the requirements of this section differ from those in Division 26 – Electrical, the requirements of this section shall take precedence.

B. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved conduit according to NEC and Division 26 – Electrical requirements.

C. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub fused when required to meet Class 2 current limit.)

D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in conduit may be used provided that cables are UL Listed for the intended application. For example, cables used in ceiling plenums shall be UL Listed specifically for that purpose.

E. All wiring in mechanical, electrical, or service rooms—or where subject to mechanical damage— shall be installed in EMT conduit.

F. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

G. Where plenum rated cable is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.

H. Where plenum rated cable is used without conduit, it shall be supported from or anchored to structural members. Cables can be supported by or anchored to ductwork or ceiling suspension systems. Cables can not be supported by conduit or sprinkler piping.

I. All wire-to-device connections shall be made at a terminal block or wire nut. All wire-to-wire connections shall be at a terminal strip or wire nut.

J. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

K. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers or interposing relays.

L. All plenum rated wiring shall be installed as continuous lengths, with no splices permitted between termination points

M. All wiring in conduit shall be installed as continuous lengths, with no splices permitted between termination points or junction boxes.

N. Maintain fire rating at all penetrations. Install plenum wiring in sleeves where it passes through walls and floors.

O. Size and type of conduit and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

P. Include one pull string in each conduit ¾ in. or larger.

Q. Control and status relays are to be located in designated enclosures only. These enclosures can include packaged equipment control panel enclosures unless they also contain Class 1 starters.

R. Conceal all conduit, except within mechanical, electrical, or service rooms. Install conduit to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g., steam pipes or flues).

S. Secure conduit with conduit clamps fastened to the structure and spaced according to code requirements. Conduit and pull boxes may not be hung on flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork.

T. Adhere to this specification's Division 26 – Electrical requirements where conduit crosses building expansion joints.

U. The Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

V. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 1 m (3 ft) in length and shall be supported at each end.. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

W. Conduit must be adequately supported, properly reamed at both ends, and left clean and free of obstructions. Conduit sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.7 COMMUNICATION WIRING:

A. The contractor shall adhere to the items listed in the "Wiring" article in Part 3 of the specification.

B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

C. Do not install communication wiring in raceway or junction boxes containing Class 1 or other Class 2 wiring from another trade such as fire alarm or security.

D. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

E. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

F. All runs of communication wiring shall be unspliced length when that length is commercially available.

G. All communication wiring shall be labeled to indicate origination and destination data.

H. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.8 INSTALLATION OF SENSORS:

A. General:
1. Install sensors in accordance with the manufacturer's recommendations.
2. Mount sensors rigidly and adequately for the environment within which the sensor operates.
3. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
4. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
5. Sensors used in mixing plenums shall be of the averaging type.
6. Low-limit sensors when specifically called out for use in mixing plenums shall be installed in a serpentine manner horizontally across the full face of the coil.
7. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
8. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.

B. Room Instrument Mounting.(where specified)
1. Room instruments, including but not limited to wall mounted thermostats and sensors located in occupied spaces shall be mounted at the same height as the light switches to provide a uniform look. Drawing notes take precedence to this height requirement.

C. Temperature Limit Switch.(where specified)

1. A temperature limit switch (Low Temperature Detector) shall be provided to sense the temperature.
2. A sufficient number of temperature limit switches shall be installed to provide complete coverage of the duct section.
3. Manual reset limit switches shall be installed in approved, accessible locations where they can be reset easily.
4. The temperature limit switch sensing element shall be installed in a serpentine pattern and in accordance with the manufacturer's installation instructions.
5. Each bend shall be supported with a capillary clip. Provide 3 m of sensing element for each 1 m^2 (1 ft of sensing element for each 1 ft^2) of coil area.

D. Averaging Temperature Sensing Elements.(where specified)
1. Sensing elements shall be installed in a serpentine pattern.
2. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

E. Outside Air Flow Measuring Stations (AFMS) .(where specified)
1. Outside Air AFMS's shall be located downstream from the Outside Air filters.
2. Pitot Tube type AFMS shall not be used if the expected velocity measurement is below 3.5 m/s (700 fpm) [or for outside airflow measurements].

F. Differential air static pressure. (where specified in point list)
1. Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a ceiling tile in a common hallway.
2. Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a ceiling tile in a common hallway.
3. Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a ceiling tile in a common hallway.

G. Water Differential pressure sensors. (where specified in point list)
1. Differential pressure sensors shall be installed with valved taps into the piping to ensure serviceability without draining the system
2. Sensors shall be mounted with bleed valves
3. After sensor installation any air shall be eliminated using the bleed valves to ensure reading accuracy
4. The sensors shall be located to ensure accessibility

H. Relative Humidity Sensors .(where specified)
1. Relative humidity sensors in supply air ducts shall be installed at least 3m (10 feet) downstream of humidity injection elements.

I. Flow Switch .(where specified)
1. Use manufacturers designated paddle for pipe diameter.
2. Adjust flow switch in accordance with manufacturer's instructions.
3. This contractor only responsible for identifying the location of the switch. Piping contractor installs the switch on the pipe.

3.9 WIRELESS TRANSCEIVER INSTALLATION. (WHERE SPECIFIED):

A. Mount transceivers in a grid like pattern not exceeding more than 25 – 100 feet line of sight between devices. Location of each transceiver shall be optimally chosen to get the best line of sight between it and at least two of its neighbors.

B. Transceivers may be mounted in the plenum space. Transceivers mounted in a metal enclosure shall utilize a remote mount antenna attached outside the metal enclosure to maintain adequate signal strength.

C. All transceiver antennas must be oriented in the vertical plane for proper RF communication.

D. Once installed ensure good communication is taking place between each device and at least two of its neighbors. Install extra transceivers if necessary to act as routers\repeaters for isolated devices with poor communication to the network.

E. Contractor shall provide a report to the owner or owner's representative illustrating good communication between all devices on the wireless network.

3.10 ACTUATORS:

A. Mount and link control damper actuators according to manufacturer's instructions.
1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
3. Damper manufacturer shall provide all mounting hardware and linkages for actuator installation.

B. Electric/Electronic
1. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.
2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.11 WARNING LABELS AND IDENTIFICATION TAGS

A. Equipment and Device labeling:
1. Labels and tags shall be keyed to the unique identifiers shown on the As-Built drawings.
2. All Enclosures and DDC Hardware shall be labeled.
3. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMS flow coefficient.
4. Labels exterior to protective enclosures shall be engraved plastic and mechanically attached to the DDC panels.

5. Labels inside protective enclosures may be attached using adhesive, but shall not be hand written.
6. Identify all other control components with p-touch labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
7. Identify room sensors relating to terminal box or valves in permanent ink inside the door of the sensor.
8. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

B. Identification of Tubing and Wiring
1. All wiring and cabling including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.
2. Permanently label or code each point of field terminal strips to show the instrument or item served.

3.12 IDENTIFICATION OF HARDWARE AND WIRING:

A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.

D. Identify room sensors relating to terminal box or valves with permanent ink inside the door of the sensor.

E. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

F. Identifiers shall match record documents.

3.13 PROGRAMMING:

A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free within the primary controller for future use.

B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index. Point Naming standard shall be agreed upon between owner and BAS contractor prior to any programming being written. Refer to Submittals section in the General Section.

C. Software Programming
1. Provide programming for the system and adhere to the sequences of operation provided. The contractor also shall provide all other system programming necessary for the operation of the system, but not specified in this document. Imbed into the control program sufficient comment statements to clearly describe each section of the program.

The comment statements shall reflect the language used in the sequences of operation and be of different font and color in text editor. Use the appropriate technique based on one of the following programming types:

a. Text-based:
   1) Must provide actions for all possible situations
   2) Must be modular and structured
   3) Must be commented
   4) Must provide line by line programming and compilation wizard to allow for ease of editing.

D. Operator Interface
   1. Standard graphics—Provide graphics for all mechanical systems and floor plans of the building (architect is responsible for providing floor plans of job to the contractor). This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.
   2. Show terminal equipment information on a "graphic" summary table. Provide dynamic information for each point shown.
   3. The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.
   4. Contractor shall provide necessary programming to create all reports referred to in Part 2 Operator Interface Software

3.14 CONTROL SYSTEM COMMISSIONING

A. Perform a two-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets that shall be submitted prior to acceptance testing. Commissioning work that requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the owner and construction manager to ensure systems are available when needed. Notify the operating personal in writing of the testing schedule so that authorized personnel from the owner and construction manager are present throughout the commissioning procedure.

B. Phase I – Field I/O Calibration and Commissioning
   1. Verify that each control panel has been installed according to plans, specifications and approved shop drawings. Calibrate, test, and have signed off each control sensor and device. Contractor will fill out daily reports with the general contractor when this work is being done so that the general contractor can notify the owner if they want to review this work. Contractor will provide a detailed commissioning report showing that this work was done. Commissioning to include, but not be limited to:
      a. Sensor accuracy at 10, 50 and 90% of range. This will be done at the factory prior to field installation. Certificate will be provided to owner during commissioning process.
      b. Sensor range.

c. Verify analog limit and binary alarm reporting.
d. Point value reporting.
e. Binary alarm and switch settings.
f. Actuator and positioned spring ranges if pneumatic actuation is utilized.
g. Fail safe operation on loss of control signal, pneumatic air, electric power, network communications, etc.

C. Phase II – System Commissioning
1. Each BMS program shall be put on line and commissioned. The contractor shall, in the presence of the owner, his engineer or their designated representative, demonstrate each programmed sequence of operation and compare the results in writing. In addition, each control loop shall be tested to verify proper response and stable control, within specified accuracy. System program test results shall be recorded on commissioning data sheets and submitted for record. Any discrepancies between the specification and the actual performance will be immediately rectified and re-tested.
2. The demonstration process shall follow that approved in Phase 1. The approved checklists and forms shall be completed for all systems as part of the demonstration.
3. The contractor shall provide at least one person equipped with two-way communication and shall demonstrate actual field operation of each control process for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the response, and action of every point and system while under control. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
4. Demonstrate compliance with sequences of operation through all modes of operation.
5. Demonstrate complete operation of operator interface.
6. Additionally, the following items shall be demonstrated:
   a. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
   b. Demand limiting (if specified in sequence). The contractor shall supply a trend data output showing the action of the demand-limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building Kw, demand limiting set point, and the status of sheddable equipment outputs.
   c. Optimum start/stop(if specified in sequence). The contractor shall supply a trend data output showing the capability of the algorithm. The change-of value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
   d. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and electronic formats.
7. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

D. Acceptance
   1. All tests described in this specification shall have been performed to the satisfaction of both the Engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the Engineer. Such tests shall then be performed as part of the warranty.
   2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved for both phase I and phase II

3.15 CLEANING

A. The contractor shall clean up all debris resulting from their activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.16 TRAINING

A. The Contractor shall provide competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed. Factory employed/certified instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 8:00 a.m. to 4:30 p.m. weekdays. All sessions will be scheduled three weeks in advance. If no one shows up after one hour from the start time, that session will be forfeited.

B. Provide a minimum of four (4) on-site, on-line, or classroom training sessions throughout the contract period for personnel designated by the owner. Each session shall be a minimum of four (4) hours each.

C. Provide one additional training/follow-up session at 6 months following building's turnover. This session shall be four hours long and must be coordinated with the building owner to review operation and any seasonal adjustments.

D. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

3.17 SEQUENCES OF OPERATION

A. See Campus Standards Section 23 09 93

END OF SECTION 230900

SECTION 230993 – SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The sequences of operations have been copied and modified from ASHRAE Guideline 36P wherever possible.

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

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment. Refer to the controls portion of this Specification and the Drawings for a complete understanding of the control sequences. Contractor shall be responsible for coordinating Division 230900 and service representatives of the equipment manufacturers to implement these control sequences along with Division 26. Prior to providing submittals, all field wiring connections shall be determined and shown on the submittals for electrical and controls interface.

B. DEFINITIONS
1. AHU: Air handling unit.
2. CV: Control valve.
3. CW: Condenser water.
4. DCV: Demand Control Ventilation.
5. DP: Differential pressure sensor.
6. EMS: Energy management system.
7. HHW: Heating hot water.
8. PI: Proportional plus integral
9. PSID: Pounds per square inch differential.
10. VAV: Variable air volume terminal unit.
11. VFD: Variable frequency drive

1.3 OBJECTIVES

A. Provide required air change rates, airflow offsets, heating, and cooling to satisfy the loads

B. Optimize energy performance through the use of trim and respond demand based response logic to reset supply air temperature, supply air pressure, and exhaust air pressure points.

C. Achieve stable operation under which ventilation rates, space temperature set-points, and space pressurization relationships are not compromised.

PART 2 - SCOPE

2.1 INFORMATION PROVIDED BY (OR IN CONJUNCTION WITH) THE TEST & BALANCE CONTRACTOR

A. Air Handler Design Information
   1. Duct design maximum static pressure, Max_DSP
   2. Minimum Fan Speed
      a. Minimum speed setpoints for all VFD-driven equipment shall be determined in accordance with the test and balance specifications for the following as applicable:
         1) Supply Fan
         2) Relief Fan
   3. Ventilation plenum pressures
      a. AbsMinDP, the absolute minimum outdoor air damper differential pressure that provides an outdoor airflow equal to the absolute minimum outdoor airflow, AbsMinOA with the OSA damper 100% open.
      b. DesMinDP, the design minimum outdoor air damper differential pressure that provides the design minimum outdoor airflow, DesMinOA with the OSA damper 100% open.

2.2 SEQUENCES OF OPERATIONS

A. This section provides detailed sequences of operation of the VAV air handling system including air handlers and VAV boxes HVAC systems and associated exhaust fans. Lists of hard-wired points and control graphs for equipment and devices are included. System level control diagrams are included on the plans.

B. This section also includes a sequence of operation to enable/disable the heating hot water system. The boilers shall be enabled based on demand.

C. General
   1. Prior to implementing the sequence of operation, the Controls Contractor shall be fully responsible to coordinate a meeting with the programmer, College maintenance staff, commissioning agent, and the Engineer of Record to insure that the functional blocks, control hardware and accessories are programmed correctly and virtually tested.
   2. These sequences are intended to be performance based. Implementations that provide the same functional result using different underlying detailed logic will be acceptable.
   3. Unless otherwise indicated, control loops shall be enabled and disabled based on the status of the system being controlled to prevent windup.
   4. When a control loop is enabled or re-enabled, it and all its constituents (such as the proportional and integral terms) shall be set initially to a Neutral value.
   5. A control loop in Neutral shall correspond to a condition that applies the minimum control effect, i.e. valves/dampers closed, VFDs at minimum speed, etc.
   6. When there are multiple outdoor air temperature sensors, the system shall use the valid sensor that most accurately represents the outdoor air conditions at the equipment being controlled.
      a. Outdoor air temperature sensors at air handler outdoor air intakes shall be considered valid only when the supply fan is proven on and unit is in Occupied Mode or in any other Mode with the economizer enabled.

b. The outdoor air temperature used for optimum start, plant lockout, and other global sequences shall be the average of all valid sensor readings. If there are four or more valid outdoor air temperature sensors, discard the highest and lowest temperature readings.

7. The term "proven" (i.e. "proven on"/ "proven off") shall mean that the equipment's DI status point (where provided, e.g. current switch, DP switch, or VFD status) matches the state set by the equipment's DO command point.
8. The term "software point" shall mean an analog variable, and "software switch" shall mean a digital (binary) variable, that are not associated with real I/O points. They shall be read/write capable (e.g. BACnet analog variable and binary variable).
9. The term "control loop" or "loop" is used generically for all control loops. These will typically be PID loops, but proportional plus integral plus derivative gains are not required on all loops. Unless specifically indicated otherwise, the following guidelines shall be followed:
   a. Use proportional only (P-only) loops for limiting loops (such as zone CO2 control loops, etc.).
   b. Do not use the derivative term on any loops unless field tuning is not possible without it.
10. To avoid abrupt changes in equipment operation, the output of every control loop shall be capable of being limited by a user adjustable maximum rate of change, with a default of 25% per minute.
11. All setpoints, timers, deadbands, PID gains, etc. listed in sequences shall be adjustable by the user with appropriate access level whether indicated as adjustable in sequences or not. Software points shall be used for these variables. Fixed scalar numbers shall not be embedded in programs except for physical constants and conversion factors.
12. Values for all points, including real (hardware) points used in control sequences shall be capable of being overridden by the user with appropriate access level (e.g. for testing and commissioning). If hardware design prevents this for hardware points, they shall be equated to a software point and the software point shall be used in all sequences.
13. Alarms
   a. There shall be 5 levels of alarm
      1) Level 1: Critical/life safety
      2) Level 2: Significant equipment failure
      3) Level 3: Non-critical equipment failure/operation
      4) Level 4: Energy conservation monitor
      5) Level 5: Maintenance indication, notification
   b. All alarms shall include a Time/Date Stamp using the standalone control module time and date.
   c. Each alarm can be configured in terms of criticality (Critical/Not Critical), operator acknowledgement (Requires Acknowledgement / Does Not Require Acknowledgement), and conditions required for an alarm to clear automatically (Requires Acknowledgement of a Return to Normal / Does Not Require Acknowledgement of a Return to Normal).
   d. An operator shall be able to sort alarms based on level, time/date, and current status.
   e. Alarms should be reported with the following information:
      1) Date and time of the alarm
      2) Level of the alarm
      3) Description of the alarm
      4) Equipment tags for the units in alarm
      5) Possible causes of the alarm, if provided by the fault detection routines

6) The Source per that serves the equipment in alarm

14. VFD Speed Points
    a. The speed analog output sent to VFDs shall be configured such that 0% speed corresponds to 0 Hz and 100% speed corresponds to maximum speed configured in the VFD.
    b. For each piece of equipment, the minimum speed shall be stored in a single software point. This value shall be written to the VFD's minimum speed setpoint via the drive's network interface; in the case of a hard-wired VFD interface, the minimum speed shall be the lowest speed command sent to the drive by the BAS. See 1.1Afor minimum speed setpoints.
15. Trim & Respond (T&R) Setpoint Reset Logic
    a. Trim & Respond setpoint reset logic and zone/system reset Requests where referenced in sequences shall be implemented as described below.
    b. A "Request" is a call to reset a static pressure or temperature setpoint, generated by downstream zones or air handling systems. These Requests are sent upstream to the plant or system that serves the zone or air handler that generated the Request.
        1) For each downstream zone or system, and for each type of setpoint reset Request listed for the zone/system, provide the following software points:
            a) Importance Multiplier (default = 1)
            b) Request-Hours. Provided System OK is true, every x minutes (default 5 minutes), add x/60 times the current number of Requests to this request-hours accumulator point. The request-hours point is reset to zero upon a global command from the system serving the zone– this global point simultaneously resets the request-hours point for all zones served by this system.
            c) Cumulative%-Request-Hours. This is the zone Request Hours divided by the zone run-hours (the hours in any Mode other than Unoccupied Mode) since the last reset, expressed as a percentage.
            d) A Level 4 alarm is generated if the zone Importance Multiplier is greater than zero, the zone/system Cumulative% Request Hours exceeds 70%, and the total number of zone run hours exceeds 40.
        2) See zone and air handling system control sequences for logic to generate Requests.
        3) Multiply the number of Requests determined from zone logic times the Importance Multiplier and send to the system that serves the zone. See system logic to see how Requests are used in Trim & Respond logic.
    c. For each upstream system or plant setpoint being controlled by a T&R loop, define the following variables. Initial values are defined in system/plant sequences below. Values for trim, respond, time step, etc. shall be tuned to provide stable control.

Variable	Definition
Device	Associated device (e.g. fan, pump)
SP_0	Initial setpoint
SP_{min}	Minimum setpoint
SP_{max}	Maximum setpoint
T_d	Delay timer
T	Time step
I	Number of Ignored Requests

Variable	Definition
R	Number of Requests from zones/systems
SP_{trim}	Trim amount
SP_{res}	Respond amount (must be opposite in sign to SP_{trim})
$SP_{res-max}$	Maximum response per time interval (must be same sign as SP_{res})

d. Trim & Respond logic shall reset setpoint within the range SPmin to SPmax. When the associated device is off, the setpoint shall be SP0. The reset logic shall be active while the associated device is proven on, starting Td after initial device start command. When active, every time step T, trim the setpoint by SPtrim. If there are more than I Requests, respond by changing the setpoint by SPres * (R-I), (i.e. the number of Requests minus the number of Ignored Requests), but no more than SPres-max. In other words, every time step T: Change setpoint by SPtrim If R>I, also change setpoint by (R-I)*SPres but no larger than SPres-max

16. Equipment Staging and Rotation
    a. The automatic even wear rotation presented in the following section is written using the basis of equipment run time to determine position in the queue for staging and is triggered only during a stage up or stage down event. These sequences will provide the most even run time across multiple pieces of equipment.
        1) Lead/lag: Unless otherwise noted, parallel staged devices (such as pumps, towers) that are not redundant shall be lead/lag alternated when more than one is off or more than one is on so that the device with the most operating hours is made the later stage device and the one with the least number of hours is made the earlier stage device. For example, assuming there are three devices, if all three are off or all are on, the staging order will simply be based on run hours from lowest to highest. If two devices are on, the one with the most hours will be set to be stage 2 while the other is set to stage 1; this may be the reverse of the operating order when the devices were started. If two devices are off, the one with the most hours will be set to be stage 3 while the other is set to stage 2; this may be the reverse of the operating order when the devices were stopped.
        2) Lead/standby: Unless otherwise noted, parallel devices (such as pumps, towers) that are 100% redundant shall be lead/standby alternated when more than one is off so that the device with the most operating hours is made the later stage device and the one with the least number of hours is made the earlier stage device. For example, assuming there are three devices, if all three are off, the staging order will be based on run hours from lowest to highest. If devices run continuously, lead/standby shall switch at an operator-specified runtime; standby device shall first be started and proven on before former lead device is changed to standby and shut off.
    b. Exceptions
        1) Operators with appropriate access level shall be able to manually command staging order via software points overriding the Even Wear or Periodic Rotation logic above, but not overriding the In Alarm or Hand Operation logic below.

2) In Alarm: If the lead device has a fault condition or has been manually switched off, a Level 2 alarm shall be generated and the device shall be set to the last stage position in the lead/lag order until alarm is reset by operator. Staging position of remaining devices shall follow the prevailing (Even Wear or Periodic Rotation) logic. A device in alarm can only automatically move up in the staging order if another device goes into alarm. Fault conditions include the following:
   a) Variable Speed Fans
      I. VFD critical fault is ON, or
      II. Status point not matching its on/off point for 3 seconds after a time delay of 15 seconds while the device is commanded on, or
      III. Supervised HOA at control panel in OFF position, or
      IV. Loss of power (e.g. VFD DC Bus voltage = zero)

3) Hand Operation: If a device is on in Hand (e.g. via an HOA switch or local control of VFD), the device shall be set to the lead device and a Level 4 alarm shall be generated. The device will remain as lead until the alarm is reset by the operator. Hand operation is determined by
   a) Variable Speed Fans
      I. HOA at control panel in ON position
      II. Status point not matching its on/off point for 15 seconds while the device is commanded off, or
      III. VFD in local "hand" mode, or

17. Supervised Hierarchical Alarm Suppression
   a. For each piece of equipment or space controlled by the BAS, define its relationship (if any) to other equipment in terms of "source", "load", or "system".
      1) A component is a "source" if it provides resources to a downstream component, such as a chiller providing chilled water to an AHU. Another example would be an AHU providing supply air to a VAV box.
      2) A component is a "load" if it receives resources from an upstream component, such as an AHU that receives chilled water from a chiller.
      3) The same component may be both a load (receiving resources from an upstream source) and a source (providing resources to a downstream load). An AHU is an example of this. It receives chilled water from the chiller and provides supply air to a VAV box.
      4) A set of components is a "system" if they share a load in common (i.e. collectively act as a source to downstream equipment, such as a set of chillers in a lead/lag relationship serving air handlers).
         a) If a single component acts as a source for downstream loads (e.g. an AHU as a source for its VAV boxes), then that single source component shall be defined as a "system" of one element.
   b. For each system as defined above, there shall be a SystemOK flag, which is either true or false.
   c. SystemOK shall be true when all of the following are true:
      1) The system is proven on.
      2) The system is achieving its temperature and/or pressure setpoint(s) for at least five minutes
      3) The system is ready and able to serve its load
   d. SystemOK shall be false while the system is starting up (i.e. before reaching setpoint) or when enough of the system's components are unavailable (in alarm, disabled, or turned off) to disrupt the ability of the system to serve its load. This threshold shall be defined by the design engineer for each system.

1) By default, Level 1 through Level 3 component alarms (indicating equipment failure) shall inhibit SystemOK. Level 4 and Level 5 component alarms (maintenance and energy efficiency alarms) shall not affect SystemOK.
2) The operator shall have the ability to individually determine which component alarms may or may not inhibit SystemOK.

e. The BAS shall selectively suppress (i.e. fail to announce; alarms may still be logged to a database) alarms for load components if SystemOK is false for the source system that serves that load.
1) If SystemOK is false for a cooling water system (i.e. chilled water system is down basis on input form the campus chilled water system) then only high temperature alarms from the loads shall be suppressed.
2) If SystemOK is false for a heating water system (i.e. heating hot water system is down basis on input form the campus heating hot water system) then only low temperature alarms from the loads shall be suppressed.
3) If SystemOK is false for an airside system (air handler, fan coil, VAV box, etc.) then all alarms from the loads shall be suppressed.

f. This hierarchical suppression shall cascade through multiple levels of load-source relationship, such that alarms at downstream loads shall also be suppressed.

g. The following types of alarms will never be suppressed by this logic:
1) Life/safety and Level 1 alarms
2) Failure-to-start alarms (i.e. equipment is commanded on, but status point shows equipment to be off)
3) Failure-to-stop/hand alarms (i.e. equipment is commanded off, but status point shows equipment to be on)

18. Time-Based Suppression Block
a. This block shall calculate a time delay period after any change in setpoint based on the difference between the controlled variable (e.g. zone temperature) at the time of the change and the new setpoint. The default time delay period shall be:
1) For thermal zone temperature alarms: 10 minutes per °F of difference, but no longer than 120 minutes, for example if setpoint changes from 68°F to 70°F and the zone temperature is 68.5°F at the time of the change, inhibit alarm for 15 minutes (1.5°F * 10 minutes/°F) after the change.
2) For thermal zone temperature cooling requests: 5 minutes per °F of difference, but no longer than 30 minutes
3) For thermal zone temperature heating requests: 5 minutes per °F of difference, but no longer than 30 minutes

D. AHU-1
1. The Direct Digital Control system (DDC) shall schedule, turn on and off, monitor, trend, and sequence the airside system as follows:
a. Pre-Occupancy Title 24 Required 1-HR (adjustable) Building Purge
1) Air handling system shall be enabled.
2) AHU-1, shall modulate to maintain the minimum airflow setting.
3) Air handling units shall operate under demand control ventilation setting.
4) Purge duration shall be scheduled for a minimum 1-hour before the scheduled occupied start hour and shall end at the scheduled occupied start hour. The purge duration shall be adjustable with a limit of a minimum 1-hour.

b. Start/Stop

1) When the air handler is OFF (stopped/disabled for any reason) the following occurs:
   a) The outside air damper is commanded closed.
   b) The exhaust air damper is commanded closed.
   c) The return air damper is commanded open.
   d) HHW & CHW valves are closed.
   e) Supply fan is commanded to stop.
   f) Relief fan is commanded to stop.
   g) All alarms are suppressed.
   1) Enable/Disable
      a) The air handler is enabled based on a time of day programmable schedule.
      b) The air handler shall start one hour before scheduled programmed occupancy and operate in accordance with paragraph 1.04.D.2 Pre-Occupancy Title 24 Required 1-HR Building Purge.
      c) The following schedule shall be programmed:

Day	Start	Stop
Monday	5:00 AM	1:00 AM the next day
Tuesday	5:00 AM	1:00 AM the next day
Wednesday	5:00 AM	1:00 AM the next day
Thursday	5:00 AM	1:00 AM the next day
Friday	5:00 AM	1:00 AM the next day
Saturday	5:00 AM	1:00 AM the next day
Sunday	5:00 AM	1:00 AM the next day
Holidays	Off	Off

   2) Start-up
      a) When the air handler is enabled automatically by the time of day schedule or manually by the operator the following occurs:
         I. The OSA damper is commanded open.
         II. The supply fan is commanded to start.
         III. The supply fan speeds up to the programmed minimum speed.
         IV. Supply fan status is confirmed by the current switch.
         V. The relief fan is commanded to start.
         VI. The relief fan speeds up to the programmed minimum speed.
         VII. Relief fan status is confirmed by the current switch.
         VIII. Supply fan speed control loop is enabled.
         IX. Relief fan speed control loop is enabled.
         X. The building pressure control loop is enabled.
         XI. The minimum OSA control loop is enabled.
         XII. The return damper control loop is enabled.

XIII. The economizer control loop is enabled.
XIV. Supply air temperature control loop is enabled.
XV. Temperature and pressure alarms are enabled after 5 minutes (adjustable).

2. Supply Fan Control
   a. Supply Fan Start/Stop
      1) Supply fan shall run when system is in the Cool-down Mode, Setup Mode, or Occupied Mode.
      2) If there are any VAV-reheat boxes on perimeter zones, supply fan shall also run when system is in Setback Mode or Warmup Mode (i.e. all Modes except Unoccupied).
      3) Totalize current airflow rate from VAV boxes to a software point, V_{ps}.
   b. Static Pressure Setpoint Reset.
   c. The trim & respond reset parameters below are a suggested as a starting place; they will most likely require adjustment during the commissioning/tuning phase.
      1) Static pressure setpoint: Setpoint shall be reset using Trim & Respond logic [see Part 2-2.1.C.15] using the following parameters:

Variable	Value
Device	Supply Fan
SP_0	0.5 inches
SP_{min}	0.1 inches
SP_{max}	Max_DSP (See PART 2 – 2.1.A)
T_d	10 minutes
T	2 minutes
I	2
R	Zone Static Pressure Reset Requests
SP_{trim}	-0.05 inches
SP_{res}	+0.06 inches
$SP_{res-max}$	+0.13 inches

   d. Static Pressure Control
      1) Supply fan speed is controlled to maintain duct static pressure at setpoint when the fan is proven on. Where the Zone Groups served by the system are small, provide multiple sets of gains that are used in the control loop as a function of a load indicator (such as supply fan airflow rate, the area of the Zone Groups that are occupied, etc.).
   e. Supply Air Temperature Control
      1) Control loop is enabled when the supply air fan is proven on, and disabled and output set to Deadband (no heating, minimum economizer) otherwise.
   f. Supply Air Temperature Setpoint

Variable	Value
Min SAT	53°F
Des SAT	55°F
Max SAT	65°F
OAT Min	60°F
OAT Max	70°F

1) During Occupied Mode: Setpoint shall be reset from Min_SAT when the outdoor air temperature is OAT_Max and above, proportionally up to T-max when the outdoor air temperature is OAT_Min and below.
2) The trim & respond reset parameters below are a suggested as a starting place; they will most likely require adjustment during the commissioning/tuning phase.
   a) T-max shall be reset using Trim & Respond logic [see Part 2-2.1.C.15]] between Des_SAT and Max_SAT. The following parameters are suggested as a starting place, but they will require adjustment during the commissioning/tuning phase:

Variable	Value
Device	AHU Supply Fan
SP_0	SP_{max}
SP_{min}	Des_SAT
SP_{max}	Max_SAT
T_d	10 minutes
T	2 minutes
I	2
R	Zone Cooling SAT Requests
SP_{trim}	+0.2°F
SP_{res}	-0.3°F
$SP_{res-max}$	-1.0°F

3) The net result of this SAT reset strategy is depicted in the chart below for Min_SAT = 53°F, Des_SAT = 55°F, Max_SAT = 65°F, OAT_Max=70°F, and OAT_Min = 60°F:

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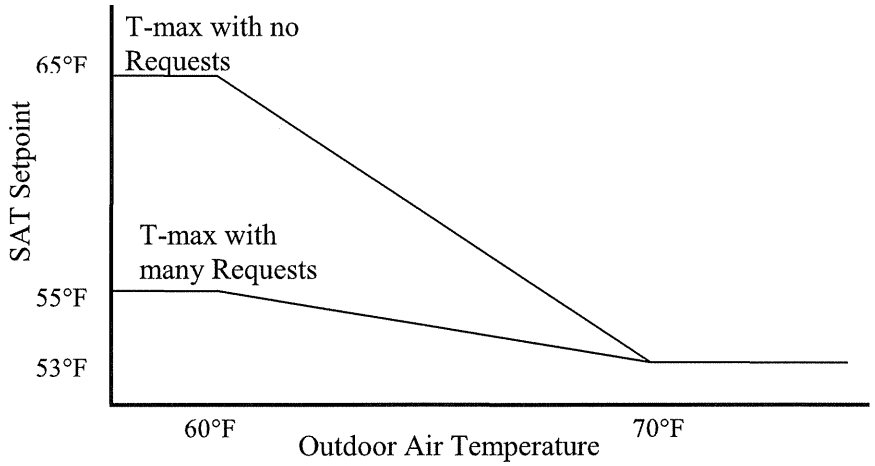
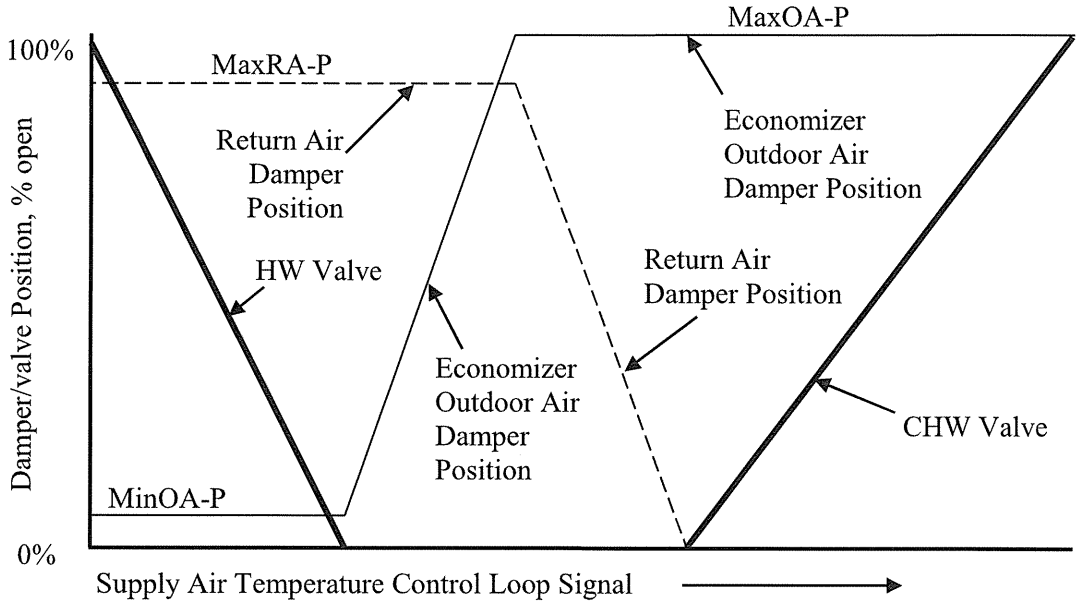


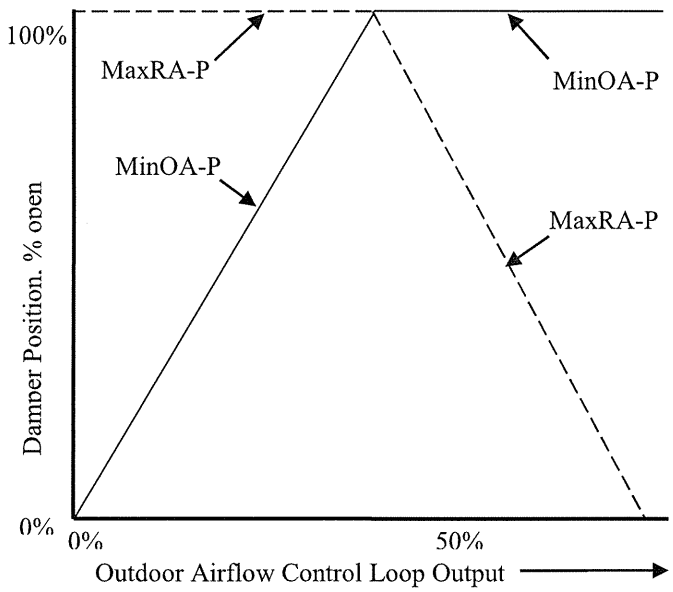
4) During Setup or Cool-Down Modes: Setpoint shall be Min_SAT.
5) During Warmup and Setback Modes: Setpoint shall be 95°F.
6) Outdoor air and return air dampers are sequenced rather than complementary (as per traditional sequences) to reduce fan power at part loads.

g. Supply air temperature shall be controlled to setpoint using a control loop whose output is mapped to sequence outdoor air damper, return air damper, and chilled water valve as shown in the diagram below.

1) Economizer damper maximum (MaxOA-P) position is limited for economizer high limit lockout.
2) MaxRA-P and MinOA-P are modulated to control minimum outdoor air volume.
3) The points of transition along the x-axis shown and described below are representative. Separate gains shall be provided for each section of the control map (economizer, chilled water), that are determined by the Contractor to provide stable control. Alternatively, Contractor shall adjust the precise value of the x-axis thresholds shown in the figure to provide stable control.



h. Minimum Outdoor Airflow Setpoints
1) Outdoor airflow setpoint, for California Title 24 ventilation:
   a) Sheet M0.02 for setpoints AbsMinOA and DesMinOA:
2) Minimum Outdoor Air Control with a single common damper for minimum outdoor air and economizer functions, and airflow measurement
3) Outdoor airflow setpoint, for California Title 24 ventilation:
   a) AbsMinOA and DesMinOA.
   b) See zone CO_2 control logic under terminal unit sequences.
   c) The minimum outdoor air setpoint MinOAsp shall be reset based on the highest zone CO_2 control loop signal from AbsMinOA at 50% signal to DesMinOA at 100% signal.
4) Minimum Outdoor Air Control Loop
   a) Minimum outdoor air control loop is enabled when the supply fan is proven on and the AHU is in Occupied Mode and disabled and output set to zero otherwise.
   b) The outdoor airflow rate shall be maintained at the minimum outdoor air setpoint MinOAsp by a reverse-acting control loop whose output is mapped to economizer damper minimum position, MinOA-P, and return air damper maximum position, MaxRA-P, as indicated in the figure below.



i. Economizer High Limit Lockout
   1) The normal sequencing of the economizer dampers (above) shall be disabled whenever the outdoor air conditions exceed the economizer high limit setpoint as specified by Title 24-2016:

Device Type	California Climate Zones	Required High Limit (Economizer Off When):
Differential Dry Bulb	8	$T_{OA} > T_{RA} - 4°F$

   2) When economizer is enabled, MaxOA-P = 100%.
   3) Once the economizer is disabled, it shall not be re-enabled within 10 minutes, and vice versa.

j. When the economizer is disabled:
   1) Return air damper shall be fully opened
   2) Wait 15 seconds, then set MaxOA-P equal to MinOA-P.
   3) Wait 3 minutes, then release return air damper for minimum outdoor air control.

3. AHU-1 Relief Fan Control
4. Relief fans are enabled and disabled with their associated supply fans.
   a. All operating relief fans that serve a common/shared air volume shall be grouped and controlled as if they were one system, running at the same speed and using the same control loop, even if they are associated with different air handling units.
   b. A relief fan shall be enabled when its associated supply fan is proven on, and shall be disabled otherwise.
   c. Relief fans shall be individually lead/lag controlled per Part 2-2.2.C.16.a.1).
   d. Building static pressure shall be time averaged with a sliding 5 minute window (to dampen fluctuations). The averaged value shall be that displayed and used for control. The setpoint shall be 0.0" W.C.

The following is intended to use barometric relief as the first stage, and then maintain many fans on at low speed to minimize noise and reduce losses through discharge dampers and louvers. Fans are staged off only when minimum speed is reached.
For best results, fan speed minimums should be set as low as possible.

E. AHU-2

1. The Direct Digital Control system (DDC) shall schedule, turn on and off, monitor, trend, and sequence the airside system as follows:
   a. Pre-Occupancy Title 24 Required 1-HR (adjustable) Building Purge
      1) Air handling system shall be enabled.
      2) AHU-1, shall modulate to maintain the minimum airflow setting.
      3) Air handling units shall operate under demand control ventilation setting.
      4) Purge duration shall be scheduled for a minimum 1-hour before the scheduled occupied start hour and shall end at the scheduled occupied start hour. The purge duration shall be adjustable with a limit of a minimum 1-hour.
   b. Start/Stop
      1) When the air handler is OFF (stopped/disabled for any reason) the following occurs:
         a) The outside air damper is commanded closed.
         b) The exhaust air damper is commanded closed.
         c) The return air damper is commanded open.
         d) HHW & CHW valves are closed.
         e) Supply fan is commanded to stop.
         f) Relief fan is commanded to stop.
         g) All alarms are suppressed.
      2) Enable/Disable
         a) The air handler is enabled based on a time of day programmable schedule.
         b) The air handler shall start one hour before scheduled programmed occupancy and operate in accordance with paragraph 1.04.D.2 Pre-Occupancy Title 24 Required 1-HR Building Purge.
         c) The following schedule shall be programmed:

Day	Start	Stop
Monday	5:00 AM	1:00 AM the next day
Tuesday	5:00 AM	1:00 AM the next day
Wednesday	5:00 AM	1:00 AM the next day
Thursday	5:00 AM	1:00 AM the next day
Friday	5:00 AM	1:00 AM the next day
Saturday	5:00 AM	1:00 AM the next day
Sunday	5:00 AM	1:00 AM the next day
Holidays	Off	Off

      3) Start-up
         a) When the air handler is enabled automatically by the time of day schedule or manually by the operator the following occurs:

I. The OSA damper is commanded open.
II. The supply fan is commanded to start.
III. The supply fan speeds up to the programmed minimum speed.
IV. Supply fan status is confirmed by the current switch.
V. The relief fan is commanded to start.
VI. The relief fan speeds up to the programmed minimum speed.
VII. Relief fan status is confirmed by the current switch.
VIII. Supply fan speed control loop is enabled.
IX. Relief fan speed control loop is enabled.
X. The building pressure control loop is enabled.
XI. The minimum OSA control loop is enabled.
XII. The return damper control loop is enabled.
XIII. The economizer control loop is enabled.
XIV. Supply air temperature control loop is enabled.
XV. Temperature and pressure alarms are enabled after 5 minutes (adjustable).

2. Supply Fan Control
   a. Supply Fan Start/Stop
      1) Supply fan shall run when system is in the Cool-down Mode, Setup Mode, or Occupied Mode.
      2) If there are any VAV-reheat boxes on perimeter zones, supply fan shall also run when system is in Setback Mode or Warmup Mode (i.e. all Modes except Unoccupied).
      3) Totalize current airflow rate from VAV boxes to a software point, V_{ps}.
   b. Static Pressure Setpoint Reset.
   c. The trim & respond reset parameters below are a suggested as a starting place; they will most likely require adjustment during the commissioning/tuning phase.
      1) Static pressure setpoint: Setpoint shall be reset using Trim & Respond logic [see Part 2-2.1.C.15] using the following parameters:

Variable	Value
Device	Supply Fan
SP_0	0.5 inches
SP_{min}	0.1 inches
SP_{max}	Max_DSP (See PART 2 – 2.1.A)
T_d	10 minutes
T	2 minutes
I	2
R	Zone Static Pressure Reset Requests
SP_{trim}	-0.05 inches
SP_{res}	+0.06 inches
$SP_{res-max}$	+0.13 inches

   d. Static Pressure Control
      1) Supply fan speed is controlled to maintain duct static pressure at setpoint when the fan is proven on. Where the Zone Groups served by the system are small, provide multiple sets of gains that are used in the control loop as a function of a load indicator (such as supply fan airflow rate, the area of the Zone Groups that are occupied, etc.).

e. Supply Air Temperature Control
   1) Control loop is enabled when the supply air fan is proven on, and disabled and output set to Deadband (no heating, minimum economizer) otherwise.

f. Supply Air Temperature Setpoint

Variable	Value
Min SAT	53°F
Des SAT	55°F
Max SAT	65°F
OAT Min	60°F
OAT Max	70°F

   1) During Occupied Mode: Setpoint shall be reset from Min_SAT when the outdoor air temperature is OAT_Max and above, proportionally up to T-max when the outdoor air temperature is OAT_Min and below.
   2) The trim & respond reset parameters below are a suggested as a starting place; they will most likely require adjustment during the commissioning/tuning phase.
      a) T-max shall be reset using Trim & Respond logic [see Part 2-2.1.C.15]] between Des_SAT and Max_SAT. The following parameters are suggested as a starting place, but they will require adjustment during the commissioning/tuning phase:

Variable	Value
Device	AHU Supply Fan
SP_0	SP_{max}
SP_{min}	Des_SAT
SP_{max}	Max_SAT
T_d	10 minutes
T	2 minutes
I	2
R	Zone Cooling SAT Requests
SP_{trim}	+0.2°F
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$SP_{res-max}$	-1.0°F

   3) The net result of this SAT reset strategy is depicted in the chart below for Min_SAT = 53°F, Des_SAT = 55°F, Max_SAT = 65°F, OAT_Max=70°F, and OAT_Min = 60°F:

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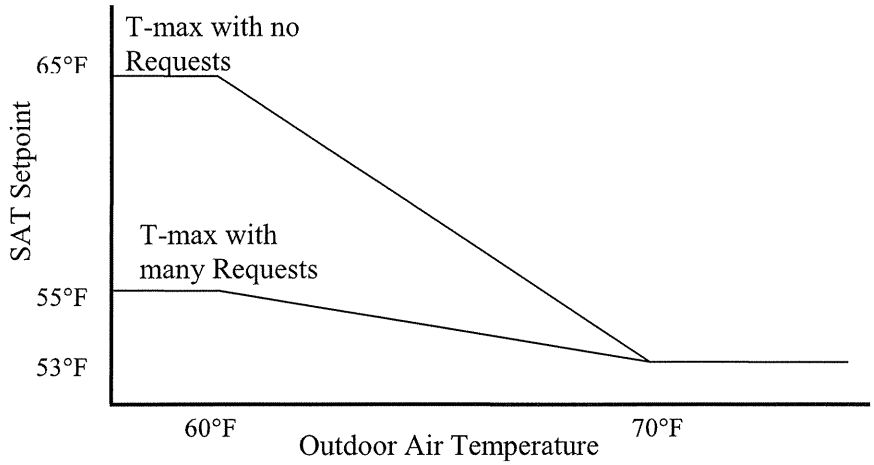
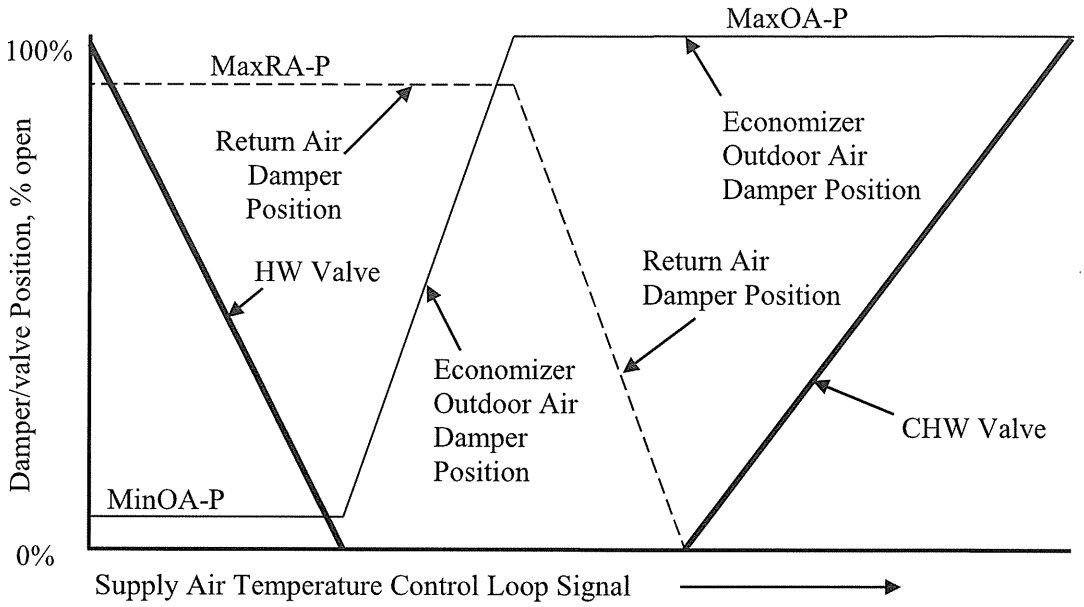


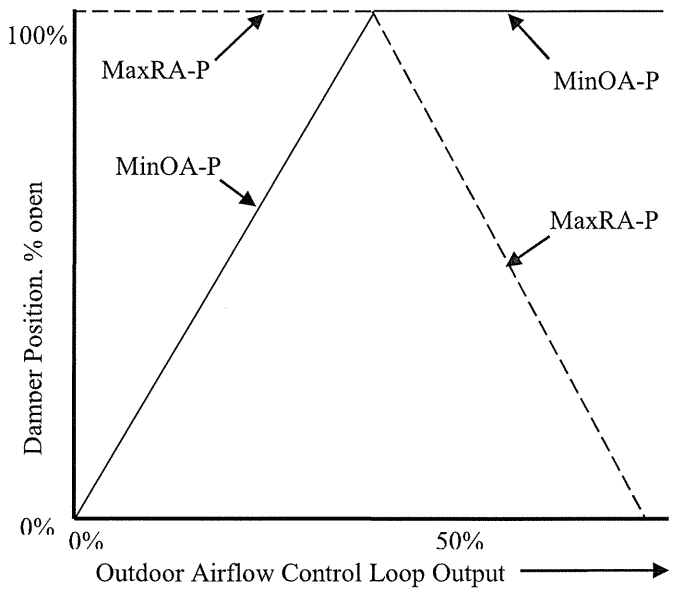
4) During Setup or Cool-Down Modes: Setpoint shall be Min_SAT.
5) During Warmup and Setback Modes: Setpoint shall be 95°F.
6) Outdoor air and return air dampers are sequenced rather than complementary (as per traditional sequences) to reduce fan power at part loads.

g. Supply air temperature shall be controlled to setpoint using a control loop whose output is mapped to sequence outdoor air damper, return air damper, and chilled water valve as shown in the diagram below.
1) Economizer damper maximum (MaxOA-P) position is limited for economizer high limit lockout.
2) MaxRA-P and MinOA-P are modulated to control minimum outdoor air volume.
3) The points of transition along the x-axis shown and described below are representative. Separate gains shall be provided for each section of the control map (economizer, chilled water), that are determined by the Contractor to provide stable control. Alternatively, Contractor shall adjust the precise value of the x-axis thresholds shown in the figure to provide stable control.



h. Minimum Outdoor Airflow Setpoints

1) Outdoor airflow setpoint, for California Title 24 ventilation:
   a) Sheet M0.02 for setpoints AbsMinOA and DesMinOA:
2) Minimum Outdoor Air Control with a single common damper for minimum outdoor air and economizer functions, and airflow measurement
3) Outdoor airflow setpoint, for California Title 24 ventilation:
   a) AbsMinOA and DesMinOA.
   b) See zone CO_2 control logic under terminal unit sequences.
   c) The minimum outdoor air setpoint MinOAsp shall be reset based on the highest zone CO_2 control loop signal from AbsMinOA at 50% signal to DesMinOA at 100% signal.
4) Minimum Outdoor Air Control Loop
   a) Minimum outdoor air control loop is enabled when the supply fan is proven on and the AHU is in Occupied Mode and disabled and output set to zero otherwise.
   b) The outdoor airflow rate shall be maintained at the minimum outdoor air setpoint MinOAsp by a reverse-acting control loop whose output is mapped to economizer damper minimum position, MinOA-P, and return air damper maximum position, MaxRA-P, as indicated in the figure below.



i. Economizer High Limit Lockout
   1) The normal sequencing of the economizer dampers (above) shall be disabled whenever the outdoor air conditions exceed the economizer high limit setpoint as specified by Title 24-2016:

Device Type	California Climate Zones	Required High Limit (Economizer Off When):
Differential Dry Bulb	8	$T_{OA} > T_{RA} - 4°F$

   2) When economizer is enabled, MaxOA-P = 100%.
   3) Once the economizer is disabled, it shall not be re-enabled within 10 minutes, and vice versa.

j. When the economizer is disabled:
   1) Return air damper shall be fully opened
   2) Wait 15 seconds, then set MaxOA-P equal to MinOA-P.
   3) Wait 3 minutes, then release return air damper for minimum outdoor air control.

1. AHU-2 Barometric Relief Control
   a. A P-only control loop maintains the building pressure at a setpoint of 0.05 inches with an output ranging from 0 to 100%. The loop is disabled and output set to zero when all fans in the relief system group are disabled.

k. Fan speed signal to all operating fans in the relief system group shall be the same and shall be equal to the PID signal but no less than the minimum speed. Except for Stage 0, discharge dampers of all relief fans shall be open only when fan is commanded on.
   1) Stage 0 (barometric relief): When relief system is enabled and the control loop output is above 5%, open the motorized dampers to all relief fans serving the relief system group that are enabled; close the dampers when the loop output drops to 0% for 5 minutes.
   2) Stage Up: When control loop is above minimum speed plus 15%, start Stage Up Timer. Each time Timer reaches 7 minutes, start next relief fan (and open associated damper) in the relief system group per lead/lag order and reset Timer to 0. Timer is reset to 0 and frozen if control loop is below

minimum speed plus 15%. Note: when staging from Stage 0 (no relief fans) to Stage 1 (one relief fan), the discharge dampers of all non-operating relief fans must be closed.

3) Stage Down: When PID loop is below minimum speed then start Stage Down Timer. Each time Timer reaches 5 minutes shut off lag fan per lead/lag order and reset Timer to 0. Timer is reset to 0 and frozen if PID loop rises above minimum speed or all fans are off. If all fans are off, go to Stage 0 (all dampers open and all fans off).

l. For fans in a Level 2 alarm and status is off, discharge damper shall be closed when stage is above Stage 0.

2. Alarms

a. Maintenance interval alarm when fan has operated for more than 1,500 hours: Level 5. Reset interval counter when alarm is acknowledged.

m. Fan alarm is indicated by the status being different from the command for a period of 15 seconds.

1) Commanded on, status off: Level 2

2) Commanded off, status on: Level 4

n. Filter pressure drop exceeds alarm limit: Level 5. The alarm limit shall vary with total airflow (if available; use fan speed if total airflow is not known) as follows:

1) $DP_x = DP_{100}(x)^{1.4}$

o. where DP100 is the high limit pressure drop at design airflow (determine limit from filter manufacturer) and DPx is the high limit at the current airflow rate x (expressed as a fraction). For instance, the setpoint at 50% of design airflow would be (.5)1.4 or 38% of the design high limit pressure drop.

p. High building pressure (more than 0.10"): Level 3

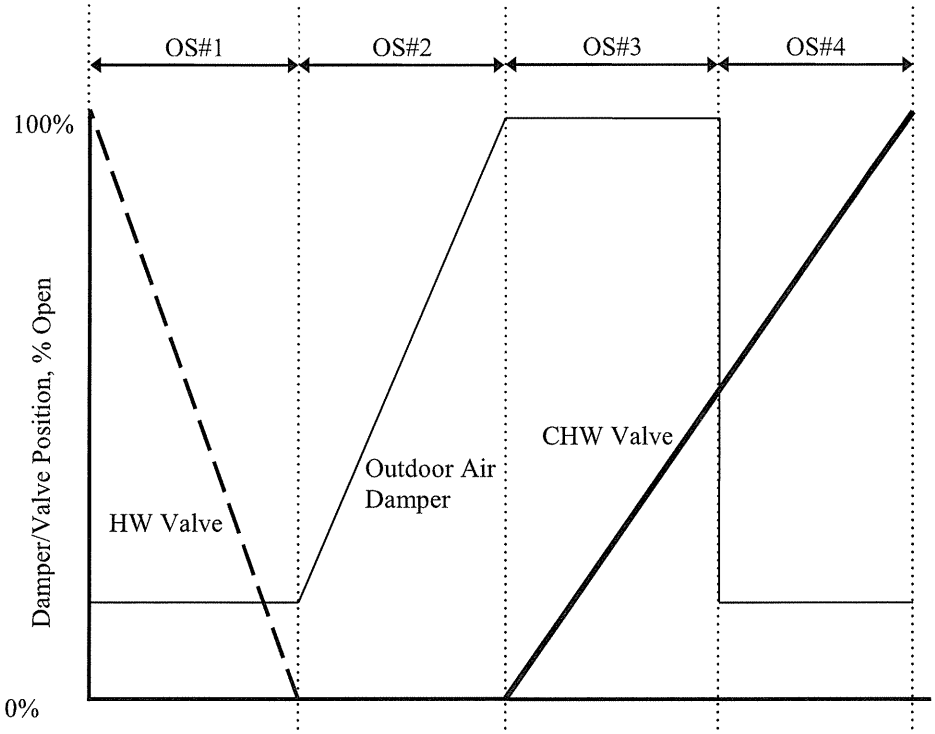
q. Low building pressure (less than 0.0", i.e. negative): Level 4

F. AHU Automatic Fault Detection and Diagnostics

1. AFDD conditions are evaluated continuously and separately for each operating air handling unit.

2. The Operating State (OS) of each AHU shall be defined by the commanded positions of the cooling coil control valve, and economizer damper in accordance with the following table and corresponding graphic.

Operating State	Heating Valve Position	Cooling Valve Position	Outdoor Air Damper Position
#1: Heating	> 0	= 0	= MIN
#2: Free Cooling, Modulating OA	= 0	= 0	MIN < X < 100%
#3: Mechanical + Economizer Cooling	= 0	> 0	= 100%
#4: Mechanical Cooling, Min OA	= 0	> 0	= MIN
#5: Unknown or Dehumidification	No other OS applies		



3. The following points must be available to the AFDD routines for each AHU:
   a. SAT = Supply air temperature
   b. MAT = Mixed air temperature
   c. RAT = Return air temperature
   d. OAT = Outdoor air temperature
   e. DSP = Duct static pressure
   f. SATSP = supply air temperature setpoint
   g. DSPSP = duct static pressure setpoint
   h. CC = cooling coil valve position command; $0\% \leq CC \leq 100\%$
   i. FS = fan speed command; $0\% \leq FS \leq 100\%$
   j. CCET = cooling coil entering temperature; depending on the AHU configuration this could be the MAT or a separate sensor for this specific purpose.
   k. CCLT = cooling coil leaving temperature; depending on the AHU configuration this could be the SAT or a separate sensor for this specific purpose.
4. The following values must be continuously calculated by the AFDD routines for each AHU:
   a. Five minute rolling averages with 1 minute sampling time of the following point values; operator shall have the ability to adjust the averaging window and sampling period for each point independently
      1) SAT_{AVG} = rolling average of supply air temperature
      2) MAT_{AVG} = rolling average of mixed air temperature
      3) RAT_{AVG} = rolling average of return air temperature
      4) OAT_{AVG} = rolling average of outdoor air temperature
      5) DSP_{AVG} = rolling average of duct static pressure
      6) $CCET_{AVG}$ = rolling average of cooling coil entering temperature
      7) $CCLT_{AVG}$ = rolling average of cooling coil leaving temperature
   b. %OA = per airflow measurement station.

c. $\%OA_{MIN}$ = Active minimum OA setpoint (MinOAsp) divided by actual total airflow (from sum of VAV box flows, or by airflow measurement station) as a percentage.

d. ΔOS = number of changes in Operating State during the previous 60 minutes (moving window)

5. The following internal variables shall be defined for each AHU. All parameters are adjustable by the operator, with initial values as given below:

a. The default values have been intentionally biased towards minimizing false alarms, if necessary at the expense of missing real alarms. This avoids excessive false alarms that will erode user confidence and responsiveness. These values shall be adjusted based on field measurement and operational experience. Values for physical factors such as fan heat, duct heat gain, and sensor error shall be measured in the field or derived from trend logs.

b. Occupancy delay and switch delays shall be refined by observing in trend data and the time required to achieve quasi steady state operation.

c. Other factors shall be tuned by observing false positives and false negatives (i.e. unreported faults). If transient conditions or noise cause false errors, increase the alarm delay. Likewise, failure to report real faults can be addressed by adjusting the heating coil, cooling coil, temperature, or flow thresholds.

Variable Name	Description	Default Value
ΔT_{SF}	Temperature rise across supply fan	2° F
ΔT_{MIN}	Minimum difference between OAT and RAT to evaluate economizer error conditions (FC#6)	10° F
ε_{SAT}	Temperature error threshold for SAT sensor	2° F
ε_{RAT}	Temperature error threshold for RAT sensor	2° F
ε_{MAT}	Temperature error threshold for MAT sensor	5° F
ε_{OAT}	Temperature error threshold for OAT sensor	2° F if local sensor @ unit. 5° F if global sensor.
ε_{F}	Airflow error threshold	30%
ε_{VFDSPD}	VFD speed error threshold	5%
ε_{DSP}	Duct static pressure error threshold	0.1"
ε_{CCET}	Cooling coil entering temperature sensor error. Equal to ε_{MAT} or dedicated sensor error	Varies, see Description
ε_{CCLT}	Cooling coil leaving temperature sensor error. Equal to ε_{SAT} or dedicated sensor error	
ΔOS_{MAX}	Maximum number of changes in Operating State	7
ModeDelay	Time in minutes to suspend Fault Condition evaluation after a change in Mode	90
AlarmDelay	Time in minutes to that a Fault Condition must persist before triggering an alarm	60

d. The purpose of ΔT_{MIN} is to ensure that the mixing box/economizer damper tests are meaningful. These tests are based on the relationship between supply, return, and outdoor air. If RAT ≈ MAT, these tests will not be accurate and will produce false alarms.

e. The following are potential Fault Conditions that can be evaluated by the AFDD routines. If the equation statement is true, then the specified fault condition exists. The Fault Conditions to be evaluated at any given time will depend on the Operating State of the AHU.

FC#1	Equation	$DSP < DSPSP - \varepsilon_{DSP}$ and $VFDSPD \geq 99\% - \varepsilon_{VFDSPD}$	Applies to OS #1 – #5
	Description	Duct static pressure is too low with fan at full speed	
	Possible Diagnosis	Problem with VFD Mechanical problem with fan Fan undersized SAT Setpoint too high (too much zone demand)	
FC#2	Equation	$MAT_{AVG} + \varepsilon_{MAT} < \min[(RAT_{AVG} - \varepsilon_{RAT}), (OAT_{AVG} - \varepsilon_{OAT})]$	Applies to OS #1 – #5
	Description	MAT too low; should be between OAT and RAT	
	Possible Diagnosis	RAT sensor error MAT sensor error OAT sensor error	
FC#3	Equation	$MAT_{AVG} - \varepsilon_{MAT} > \max[(RAT_{AVG} + \varepsilon_{RAT}), (OAT_{AVG} + \varepsilon_{OAT})]$	Applies to OS #1 – #5
	Description	MAT too high; should be between OAT and RAT	
	Possible Diagnosis	RAT sensor error MAT sensor error OAT sensor error	
FC#4	Equation	$\Delta OS > \Delta OS_{MAX}$	Applies to OS #1 – #5
	Description	Too many changes in Operating State	
	Possible Diagnosis	Unstable control due to poorly tuned loop or mechanical problem	
FC#5	Equation	$SAT_{AVG} + \varepsilon_{SAT} \leq MAT_{AVG} - \varepsilon_{MAT} + \Delta T_{SF}$	Applies to OS #1
	Description	SAT too low; should be higher than MAT	
	Possible Diagnosis	SAT sensor error MAT sensor error Cooling coil valve leaking or stuck open Fouled or undersized heating coil HW temperature too low or HW unavailable	

FC#6	Equation	$\lvert RAT_{AVG} - OAT_{AVG} \rvert \geq \Delta T_{MIN}$ and $\lvert \%OA - \%OA_{MIN} \rvert > \varepsilon_F$	Applies to OS #1, #4
	Description	OA fraction is too low or too high; should equal $\%OA_{MIN}$	
	Possible Diagnosis	RAT sensor error MAT sensor error OAT sensor error Leaking or stuck economizer damper or actuator	
FC#8	Equation	$\lvert SAT_{AVG} - \Delta T_{SF} - MAT_{AVG} \rvert > \sqrt{\varepsilon_{SAT}^2 + \varepsilon_{MAT}^2}$	Applies to OS #2
	Description	SAT and MAT should be approximately equal	
	Possible Diagnosis	SAT sensor error MAT sensor error Cooling coil valve leaking or stuck open	
FC#9	Equation	$OAT_{AVG} - \varepsilon_{OAT} > SATSP - \Delta T_{SF} + \varepsilon_{SAT}$	Applies to OS #2
	Description	OAT is too high for free cooling without additional mechanical cooling	
	Possible Diagnosis	SAT sensor error OAT sensor error Cooling coil valve leaking or stuck open	
FC#10	Equation	$\lvert MAT_{AVG} - OAT_{AVG} \rvert > \sqrt{\varepsilon_{MAT}^2 + \varepsilon_{OAT}^2}$	Applies to OS #3
	Description	OAT and MAT should be approximately equal	
	Possible Diagnosis	MAT sensor error OAT sensor error Leaking or stuck economizer damper or actuator	
FC#11	Equation	$OAT_{AVG} + \varepsilon_{OAT} < SATSP - \Delta T_{SF} - \varepsilon_{SAT}$	Applies to OS #3
	Description	OAT is too low for 100% OA cooling	
	Possible Diagnosis	SAT sensor error OAT sensor error Leaking or stuck economizer damper or actuator	
FC#12	Equation	$SAT_{AVG} - \varepsilon_{SAT} - \Delta T_{SF} \geq MAT_{AVG} + \varepsilon_{MAT}$	Applies to OS #3, #4
	Description	SAT too high; should be less than MAT	
	Possible Diagnosis	SAT sensor error MAT sensor error Cooling coil valve stuck closed or actuator failure Fouled or undersized cooling coil CHW temperature too high or CHW unavailable	

FC#13	Equation	$SAT_{AVG} > SATSP + \varepsilon_{SAT}$ and $CC \geq 99\%$	Applies to OS #3, #4
	Description	SAT too high in full cooling	
	Possible Diagnosis	SAT sensor error Cooling coil valve stuck closed or actuator failure Fouled or undersized cooling coil CHW temperature too high or CHW unavailable	
FC#14	Equation	$CCET_{AVG} - CCLT_{AVG} \geq \sqrt{\varepsilon_{CCET}^2 + \varepsilon_{CCLT}^2} + \Delta T_{SF}^*$ *Fan heat factor included or not depending on location of sensors used for CCET and CCLT	Applies to OS #1, #2
	Description	Temperature drop across inactive cooling coil	
	Possible Diagnosis	CCET sensor error CCLT sensor error Cooling coil valve stuck open or leaking.	

f. A subset of all potential fault conditions is evaluated by the AFDD routines. The set of applicable fault conditions depends on the Operating State of the AHU:
   1) In OS#2 (Modulating Economizer), the following Fault Conditions shall be evaluated:
      a) FC#1: Duct static pressure is too low with fan at full speed
      b) FC#2: MAT too low; should be between RAT and OAT
      c) FC#3: MAT too high; should be between RAT and OAT
      d) FC#4: Too many changes in Operating State
      e) FC#8: SAT and MAT should be approximately equal
      f) FC#9: OAT is too high for free cooling without mechanical cooling
      g) FC#14: Temperature drop across inactive cooling coil
      h) FC#15: Temperature drop across inactive heating coil
   2) In OS#3 (Mechanical + 100% Economizer Cooling), the following Fault Conditions shall be evaluated:
      a) FC#1: Duct static pressure is too low with fan at full speed
      b) FC#2: MAT too low; should be between RAT and OAT
      c) FC#3: MAT too high; should be between RAT and OAT
      d) FC#4: Too many changes in Operating State
      e) FC#10: OAT and MAT should be approximately equal
      f) FC#11: OAT too low for 100% OA
      g) FC#12: SAT too high; should be less than MAT
      h) FC#13: SAT too high in full cooling
      i) FC#15: Temperature drop across inactive heating coil
   3) In OS#4 (Mechanical Cooling, Min OA), the following Fault Conditions shall be evaluated:
      a) FC#1: Duct static pressure is too low with fan at full speed
      b) FC#2: MAT too low; should be between RAT and OAT
      c) FC#3: MAT too high; should be between RAT and OAT
      d) FC#4: Too many changes in Operating State
      e) FC#6: OA fraction is too low or too high; should equal %OAMIN
      f) FC#12: SAT too high; should be less than MAT
      g) FC#13: SAT too high in full cooling

4) In OS#5 (Other), the following Fault Conditions shall be evaluated:
   a) FC#1: Duct static pressure is too low with fan at full speed
   b) FC#2: MAT too low; should be between RAT and OAT
   c) FC#3: MAT too high; should be between RAT and OAT
   d) FC#4: Too many changes in Operating State

g. For each air handler, the operator shall be able to suppress the alarm for any Fault Condition.

h. Evaluation of Fault Conditions shall be suspended under the following conditions:
   1) When AHU is not operating.
   2) For a period of Mode Delay minutes following a change in Mode (e.g. from Warm up to Occupied) of any Zone Group served by the AHU.
   3) Fault Conditions that are not applicable to the current Operating State shall not be evaluated.
   4) A Fault Condition that evaluates as true must do so continuously for Alarm Delay minutes before it is reported to the operator.
   5) When a Fault Condition is reported to the operator, it shall be a Level 3 alarm and shall include the description of the fault and the list of possible diagnoses from the table.

G. General Thermal Zone Information

1. Zone Temperature Setpoints

a. Default set points shall be based on zone type:

Zone Type	Occupied		Unoccupied	
	Heating	Cooling	Heating	Cooling
Conference Center	68°F	73°F	45°F	90°F
Office/Conference	68°F	73°F	45°F	90°F
Storage, etc.	68°F	85°F	45°F	90°F
Toilet/Janitor	68°F	78°F	45°F	90°F
Warehouse	68°F	78°F	45°F	90°F
Mech/Elec Rooms	NA	80°F	NA	80°F

2. CO_2 Setpoints

a. Maximum CO_2 setpoint for all zones with demand control ventilation (DCV) shall be 1,000 ppm. VAV schedule column "DCV Control" indicates which zones shall have DCV.

3. VAV Box Design Information

a. VAV Reheat Terminal Unit

b. Refer to VAV schedule on drawing M002 for:
   1) Zone maximum cooling airflow setpoint (Vcool-max)
   2) Zone minimum airflow setpoint (Vmin)
   3) Zone maximum heating airflow setpoint (Vheat-max)

c. Zone maximum discharge air temperature above heating setpoint MaxΔT shall be 20°F.

H. Zone Group Assignments

1. The controls contractor shall submit the Zone Group Assignments to the College for their review and approval.

2. The zone groups shall are based on the following:
   a. All zones in a zone group should be served by the same air handling unit.
   b. Each department shall be its own zone group unless due exterior exposure or requirements listed below there needs to be more than one zone group.
   c. A Zone Group shall not span floors (per Section 6.4.3.3.4 of ASHRAE 90.1 2013).

d. A Zone Group shall not exceed 25,000 square feet (per Section 6.4.3.3.4 of ASHRAE 90.1 2013).
e. If future occupancy patterns are known, a single Zone Group shall should not include spaces belonging to more than one department/tenant.

First Floor Zone Group Schedule			
Zone Group Number	VAV boxes serves	Area Severed	Room Numbers
ZG1-1	VAV 1-00, VAV 1-01	The Spot	J101
ZG1-2	VAV 1-02	Student Life - West Ext	J102-1 J102-2
ZG1-3	VAV 1-03, VAV 1-04, VAV 1-06	Student Life – Interior & ASG	J102, J102-3, J103-2
ZG1-4	VAV 1-07	Conference Room	J104
ZG1-5	VAV 1-05, VAV 1-08, VAV 1-09	Lobby, Corridor Restrooms	J100-1, J100-2, J106, J107, J122, J123, J124
ZG1-6	VAV 1-10, VAV 1-13	DSPS – West Exterior	J108-1 to J108-4
ZG1-7	VAV -1-11	DSPS - Interior	
ZG1-8	VAV 1-14 VAV 1-15	DSPS – South Exterior	J108
ZG1-9	VAV 1-12	Conference Room	J109
ZG1-10	VAV 1-16, VAV 1-17, VAV 1-18, VAV 1-19 VAV 1-20, VAV 1-23, VAV 1-24	Health & Wellness-Interior	J110 to J110-6, J110-8 to J110-18
ZG1-11	VAV 1-21, VAV 1-22	Health & Wellness-Exterior South	J110-7, J110-19, J110-20
ZG1-12	VAV 1-25, VAV 1-26	Warehouse, Receiving & Storage	J129 to J130-2
ZG1-13	VAV 1-27, VAV 1-33	Staff Lounge	J112, J121
ZG1-14	VAV 1-28 to VAV 1-31	Grab'N'Go., Campus Store	J116, J117 to J117-1A
ZG1-15	VAV 1-34, VAV 1-36	Coffe Bar, Prep Area	J118, J118-1
ZG1-16	VAV 1-36 to VAV 1-39	Mailroom, Reprographics	J119 to J120-2

Second Floor Zone Group Schedule			
Zone Group Number	VAV boxes serves	Area Severed	Room Numbers
ZG2-1	VAV 2-01 to VAV 2-03	Financial Aid - Exterior West	J201-1 to J201-5
ZG2-2	VAV 2-04 to VAV 2-06	Financial Aid - Interior	J201
ZG2-3	VAV 2-07, VAV 2-08, VAV 2-11, VAV 2-12	Student Financial Services -Interior	J202 Interior, J202-1, J202-2, J203, J203-1
ZG2-4	VAV 2-09, VAV 2-10	Student Financial Services -Exterior West	J202 exterior, J202-3
ZG2-5	VAV 2-13	Staff Lounge	J204
ZG2-6	VAV 2-14 to VAV 2-18	Lobby, Corridor Restrooms, Lactation Room	J200-1 to J200-3, J205 to J207
ZG2-7	VAV 2-19 to VAV 2-21	International Studies-Exterior West	J208-1 to J208-3
ZG2-8	VAV 2-22	International Studies	J208, J208-4
ZG2-9	VAV 2-24	SSSP Upward Bound - Interior	J209, J209-1
ZG2-10	VAV 2-25, VAV 2-26	SSSP Upward Bound	J208-2 to J208-5
ZG2-11	VAV 2-27, VAV 2-29, VAV 2-35	EOPS/CalWorks - Interior	J211, J212, J215
ZG2-12	VAV 2-28, VAV 2-30, VAV 2-31	EOPS/CalWorks – Exterior South	J212-2 to J212-7 J130-2
ZG2-13	VAV 2-32 to VAV 2-34	EOPS/CalWorks – Exterior East	J212-8 to J212-11, J215-1
ZG2-14	VAV 2-36 to VAV 2-42	Conference Center	J218 to J220

I.

I. VAV Box Controllable Minimum

1. This section is used to determine the lowest possible VAV box airflow setpoint allowed by the controls (Vm) used in VAV box control sequences. The minimums shall be stored as software points.
2. Option 1: If the VAV box controls simply stop moving the damper when the airflow reading becomes too low to register and then re-enables the damper when the airflow reading rises above that threshold, Vm shall be equal to zero.
3. Option 2: The minimum setpoint Vm shall be determined as follows:
   a. Determine the velocity pressure sensor reading VPm in inches H2O that will give a reliable flow indication. If this information is not provided by the sensor manufacturer, determine the velocity pressure that will result in a digital reading from the transducer and A/D converter of 12 bits or counts (assuming a 10 bit A/D converter). This is considered sufficient resolution for stable control.
   b. Determine the minimum velocity vm for each VAV box size and model. If the VAV box manufacturer provides an amplification factor F for the flow pickup, calculate the minimum velocity vm as

$$v_m = 4005\sqrt{\frac{VP_m}{F}}$$

1) Where F is not known it can be calculated from the measured CFM at 1 inch signal from the VP sensor

$$F = \left(\frac{4005A}{CFM_{@1"}}\right)^2$$

2) Where A is the nominal duct area (ft^2), equal to where D is the nominal duct diameter (inches).

$$A = \pi\left(\frac{D}{24}\right)^2$$

3) Calculate the minimum airflow setpoint allowed by the controls (Vm) for each VAV box size as

$$Vm = v_m A$$

J.

J. Damper/Valve Position
1. Knowledge of damper and valve position are required for proper generation of Trim & Respond reset requests.
2. The following are acceptable methods for determining position:
   a. Analog actuator. Position may be assumed to be equal to analog signal to actuator.
   b. Floating actuator. Provide either
      1) Position feedback analog input
      2) Position estimated by timing pulse-open and pulse-closed commands with auto-zeroing whenever zone is in Unoccupied Mode and damper is driven full closed. This option is not acceptable for 24/7 applications.

K. Generic Thermal Zones
1. Single zone VAV Boxes as part of the VAV air handling systems, setpoints
   a. Each zone shall have separate occupied and unoccupied heating and cooling setpoints.
   b. The active setpoints shall be determined by the Operating Mode of the Zone Group.
      1) The setpoints shall be the occupied setpoints during Occupied Mode, Warm up Mode, and Cool-down Mode.
      2) The setpoints shall be the unoccupied setpoints during Unoccupied Mode, Setback Mode, and Setup Mode.
   c. The software shall prevent
      1) The heating setpoint from exceeding the cooling setpoint minus 1°F (i.e. the minimum difference between heating and cooling setpoints shall be 1°F)
      2) The unoccupied heating setpoint from exceeding the occupied heating setpoint; and
      3) The unoccupied cooling setpoint from being less than the occupied cooling setpoint.
   d. Where the zone has a local setpoint adjustment knob/button
      1) The setpoint adjustment offsets established by the occupant shall be software points that are persistent (e.g. not reset daily), but the actual offset

used in control logic shall be adjusted based on limits and modes as describe below.

2) The adjustment shall be capable of being limited in software.
   a) As a default, the active occupied cooling setpoint shall be limited between 72°F and 80°F.
   b) As a default, the active occupied heating setpoint shall be limited between 65°F and 72°F.
3) The active heating and cooling setpoints shall be independently adjustable, respecting the limits and anti-overlap logic described above. If zone thermostat provides only a single setpoint adjustment, then the adjustment shall move both the active heating and cooling setpoints upwards or downwards by the same amount, within the limits described above.
4) The adjustment shall only affect occupied setpoints in Occupied Mode and shall have no impact on setpoints in all other modes.
5) At the onset of demand limiting, the local setpoint adjustment value shall be frozen. Further adjustment of the setpoint by local controls shall be suspended for the duration of the demand limit event.

e. Cooling Demand Limit Setpoint Adjustment: The active cooling setpoints for all zones shall be increased when a demand limit is imposed on the associated Zone Group. The operator shall have the ability to exempt individual zones from this adjustment through the normal BAS user interface. Changes due to demand limits are not cumulative.
   1) At Demand Limit Level 1, increase setpoint by 1°F.
   2) At Demand Limit Level 2, increase setpoint by 2°F.
   3) At Demand Limit Level 3, increase setpoint by 4°F.

f. Heating Demand Limit Setpoint Adjustment: The active heating setpoints for all zones shall be decreased when a demand limit is imposed on the associated Zone Group. The operator shall have the ability to exempt individual zones from this adjustment through the normal BAS user interface. Changes due to demand limits are not cumulative.
   1) At Demand Limit Level 1, decrease setpoint by 1°F.
   2) At Demand Limit Level 2, decrease setpoint by 2°F.
   3) At Demand Limit Level 3, decrease setpoint by 4°F.

g. Hierarchy of Setpoint Adjustments: The following adjustment restrictions shall prevail in order from highest to lowest priority:
   1) Setpoint overlap restriction 1°F.
   2) Absolute limits on local setpoint adjustment 72°F to 80°F
   3) Demand limit
      a) Occupancy sensors: Change of setpoint by occupancy sensor is added to change of setpoint by any demand limits in effect.
      b) Local setpoint adjustment: Any changes to setpoint by local adjustment are frozen at the onset of the demand limiting event and remain fixed for the duration of the event. Additional local adjustments are ignored for the duration of the demand limiting event.
   4) Scheduled setpoints based on Zone Group mode

h. Local override: When thermostat override buttons are depressed, the call for Occupied Mode operation shall be sent up to the Zone Group control for 60 minutes.

i. Control Loops
   1) Two separate control loops shall operate to maintain space temperature at setpoint, the Cooling Loop and the Heating Loop.

2) The Heating Loop shall be enabled whenever the space temperature is below the current zone heating setpoint temperature, and disabled when space temperature is above the current zone heating setpoint temperature and the Loop output is zero for 30 seconds. The Loop may remain active at all times if provisions are made to minimize integral windup.
3) The Cooling Loop shall be enabled whenever the space temperature is above the current zone cooling setpoint temperature, and disabled when space temperature is below the current zone cooling setpoint temperature and the Loop output is zero for 30 seconds. The Loop may remain active at all times if provisions are made to minimize integral windup.

j. The Cooling Loop shall maintain the space temperature at the active cooling setpoint. The output of the loop shall be a software point ranging from 0% (no cooling) to 100% (full cooling).
k. The Heating Loop shall maintain the space temperature at the active heating setpoint. The output of the loop shall be a software point ranging from 0% (no heating) to 100% (full heating).
l. Loops shall use proportional + integral logic or other technology with similar performance. Proportional-only control is not acceptable, although the integral gain shall be small relative to the proportional gain. P and I gains shall be adjustable by the operator.
m. See other sections for how the outputs from these loops are used.

2. Zone State
   a. Heating: when the output of the space heating control loop is nonzero and the output of the cooling loop is equal to zero.
   b. Cooling: when the output of the space cooling control loop is nonzero and the output of the heating loop is equal to zero.
   c. Deadband: when not in either Heating or Cooling.
3. Zone Alarms
   a. Zone temperature alarms
      1) High temperature alarm
         a) If the zone is 3°F above cooling setpoint for 10 minutes, generate Level 3 alarm.
         b) If the zone is 5°F above cooling setpoint for 10 minutes, generate Level 2 alarm.
      2) Low temperature alarm
         a) If the zone is 3°F below heating setpoint for 10 minutes, generate Level 3 alarm.
         b) If the zone is 5°F below heating setpoint for 10 minutes, generate Level 2 alarm.
      3) Suppress zone temperature alarms as follows:
         a) After zone setpoint is changed per 1.1A.
         b) While Zone Group is in Warmup or Cool-down Modes.
         c) For zones with an Importance multiplier [see 1.1A] of zero for its static pressure reset, SAT reset, or Hot Water reset Trim & Respond loops.
   b. For zones with CO2 sensors:
      1) CO2 sensors: If the CO_2 concentration is less than 300 ppm, or the zone is in Unoccupied Mode for more than 2 hours and zone CO_2 concentration exceeds 600 ppm, generate a Level 3 alarm. The alarm text shall identify the sensor and indicate that it may be out of calibration.

2) If the CO_2 concentration exceeds setpoint plus 10% for more than 10 minutes generate a Level 3 alarm.

L. Zone Groups
1. Each system shall be broken into separate Zone Groups composed of a collection of one or more zones served by a single air handler. See Part 2 – 2.2.K for zone group assignments.
2. Each Zone Group shall be capable of having separate occupancy schedules and Operating Modes from other Zone Groups.
3. All zones in each Zone Group shall be in the same Operating Mode at all times. If one zone in a Zone Group is placed in any mode other than Unoccupied Mode (due to override, sequence logic, or scheduled occupancy) all zones in that Zone Group shall enter that mode.
4. A Zone Group may be in only one mode at any given time.
5. For each Zone Group, provide a set of testing/commissioning software switches that override all zones served by the Zone Group. Provide a separate software switch for each of the zone-level override switches listed under "Testing and Commissioning Overrides" in terminal unit sequences. When the value of a Zone Group's override switch is changed, the corresponding override switch for every zone in the Zone Group shall change to the same value. Subsequently, the zone-level override switch at may be changed to a different value. The value of the zone-level switch has no effect on the value of the Zone Group switch, and the value of the Zone Group switch only affects the zone-level switches when the Zone Group switch is changed.
6. Zone Group Operating Modes: Each Zone Group shall have the following modes:
   a. Occupied Mode: A Zone Group is in the Occupied Mode when any of the following is true:
      1) The time of day is between the Zone Group's scheduled occupied start and stop times.
      2) The schedules have been overridden by the Occupant Override System.
      3) Any zone local override timer (initiated by local override button) is nonzero.
   b. Warmup Mode: For each zone, the BAS shall calculate the required warm up time based on the zone's occupied heating setpoint, the current zone temperature, the outdoor air temperature, and a mass/capacity factor for each zone. The mass factor shall be manually adjusted or self-tuned by the BAS. If automatic, the tuning process shall be turned on or off by a software switch, to allow tuning to be stopped after the system has been trained. Warmup Mode shall start based on the zone with the longest calculated warm up time requirement, but no earlier than 3 hours before the start of the scheduled occupied period and shall end at the scheduled Occupied start hour.
   c. Cool-Down Mode: For each zone, the BAS shall calculate the required cool down time based on the zone's occupied cooling setpoint, the current zone temperature, the outdoor air temperature, and a mass/capacity factor for each zone. The mass factor shall be manually adjusted or self-tuned by the BAS. If automatic, the tuning process shall be turned on or off by a software switch, to allow tuning to be stopped after the system has been trained. Cool-down Mode shall start based on the zone with the longest calculated cool-down time requirement, but no earlier than 3 hours before the start of the scheduled occupied period and shall end at the scheduled Occupied start hour.
   d. Setback Mode: During Unoccupied Mode, if any 5 zones (or all zones, if fewer than 5) in the Zone Group fall below their unoccupied heating setpoints, the Zone

Group shall enter Setback Mode until all spaces in the Zone Group are 2°F above their unoccupied setpoints.

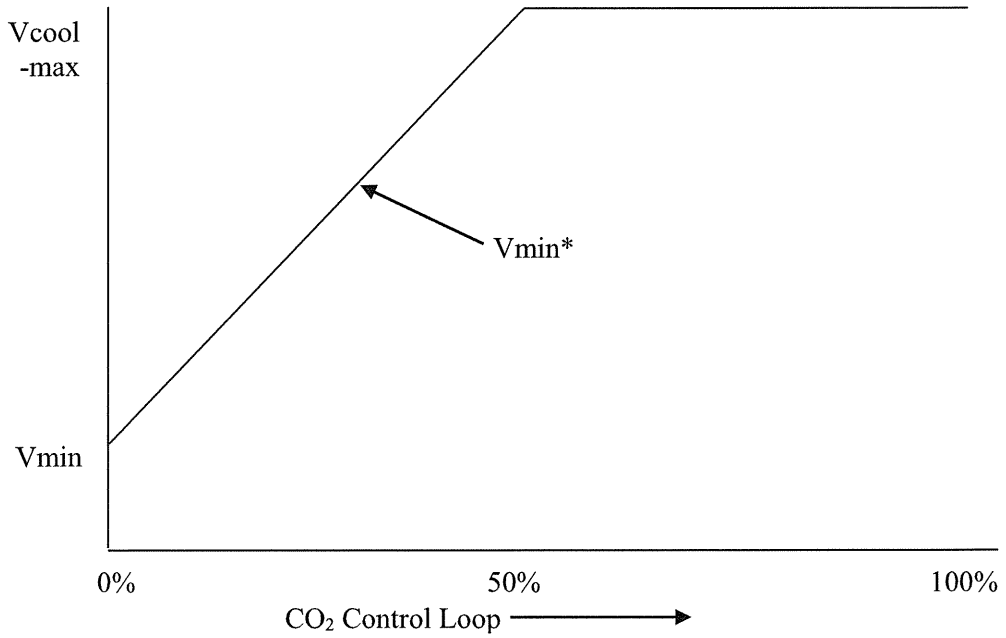
e. Freeze Protection Setback Mode: During Unoccupied Mode, if any single zone falls below 40°F, the Zone Group shall enter Setback Mode until all zones are above 45°F, and a Level 3 alarm shall be set.

f. Setup Mode: During Unoccupied Mode, if any 5 zones (or all zones, if fewer than 5) in the Zone rise above their unoccupied cooling setpoints, the Zone Group shall enter Setup Mode until all spaces in the Zone Group are 2°F below their unoccupied setpoints.

g. Unoccupied Mode: When the Zone Group is not in any other mode.

M. VAV Reheat Terminal Unit

1. See Generic Thermal Zones (Section N above) for setpoints, loops, control modes, alarms, etc.
2. See sheet M0.03 for zone minimum airflow setpoints Vmin, zone maximum cooling airflow setpoint Vcool-max, zone maximum heating design airflow setpoint Vheat-max, and the maximum discharge air temperature rise above heating setpoint, MaxΔT.
3. The occupied minimum airflow Vmin* shall be equal to Vmin except as follows:
   a. If Vmin is non-zero and less than the lowest possible airflow setpoint allowed by the controls (Vm), Vmin* shall be set equal to Vm. The minimum setpoint Vm shall be determined in accordance with Section L above.
   b. If the zone has a CO_2 sensor
      1) See section J above for CO2 setpoints.
      2) During Occupied Mode, a P-only loop shall maintain CO_2 concentration at setpoint; reset 0% at (setpoint - 200 PPM) and 100% at setpoint.
         a) The loop output from 0% to 50% shall reset the occupied minimum airflow setpoint (Vmin*) from the zone minimum airflow setpoint Vmin up to maximum cooling airflow setpoint Vcool-max, as shown below. The loop output from 50% to 100% will be used at the system level to reset outdoor air minimum; see AHU controls.

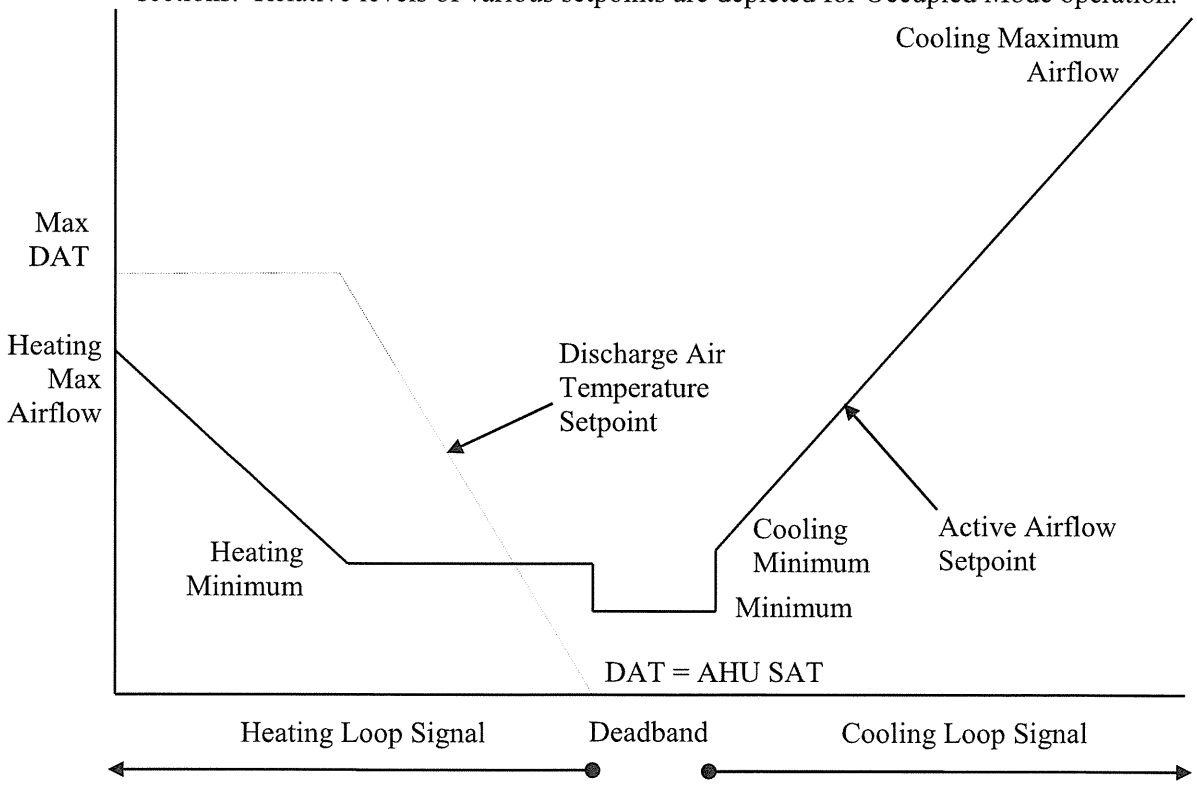


4. Loop is disabled and output set to zero when the zone is not in Occupied Mode.

5. Active maximum and minimum setpoints shall vary depending on the Mode of the Zone Group the zone is a part of:

Setpoint	Occupied	Cool-down	Setup	Warmup	Setback	Unoccupied
Cooling maximum	Vcool-max	Vcool-max	Vcool-max	0	0	0
Cooling minimum	Vmin*	0	0	0	0	0
Minimum	Vmin*	0	0	0	0	0
Heating minimum	Vmin*	0	0	Vheat-max	Vheat-max	0
Heating maximum	Max(Vheat-max, Vmin*)	Vheat-max	0	Vcool-max	Vcool-max	0

6. Control logic is depicted schematically in the figure below and described in the following sections. Relative levels of various setpoints are depicted for Occupied Mode operation.



a. When the Zone State is Cooling, the Cooling Loop output shall be mapped to the airflow setpoint from the cooling minimum to the cooling maximum airflow setpoints. Hot water valve is closed unless the discharge air temperature is below the minimum setpoint [see 2.2M.6.e below].

1) If supply air temperature from the air handler is greater than room temperature, cooling supply airflow setpoint shall be no higher than the minimum.

b. When the Zone State is Deadband, the active airflow setpoint shall be the minimum airflow setpoint. Hot water valve is closed unless the discharge air temperature is below the minimum setpoint [see 2.2M.6.e below].
c. When the Zone State is Heating, the Heating Loop shall maintain space temperature at the heating setpoint as follows:
    1) From 0-50%, the Heating Loop output shall reset the discharge temperature setpoint from the current AHU SAT setpoint to a maximum of MaxΔT above space temperature setpoint. The airflow setpoint shall be the heating minimum.
    2) From 51%-100%, if the discharge air temperature is greater than room temperature plus 5°F, the Heating Loop output shall reset the airflow setpoint from the heating minimum airflow setpoint to the heating maximum airflow setpoint.
d. The hot water valve shall be modulated to maintain the discharge temperature at setpoint. (Directly controlling heating off the zone temperature control loop is not acceptable.)
e. In Occupied Mode, the hot water valve shall be modulated to maintain a discharge air temperature no lower than 50°F.
f. The VAV damper shall be modulated by a control loop to maintain the measured airflow at the active setpoint.

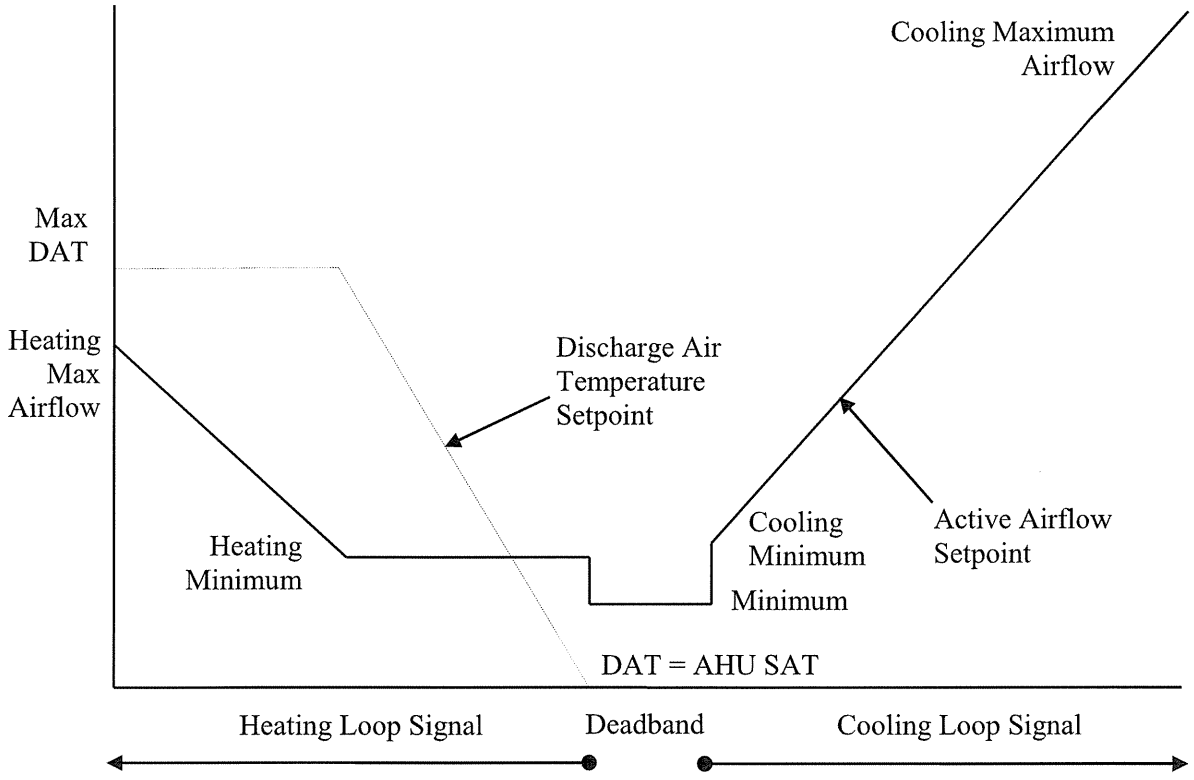
7. Alarms
    a. Low airflow
        1) If the measured airflow is less than 70% of setpoint for 5 minutes while setpoint is greater than zero, generate a Level 3 alarm.
        2) If the measured airflow is less than 50% of setpoint for 5 minutes while setpoint is greater than zero, generate a Level 2 alarm.
        3) If a zone has an Importance multiplier of 0 [see 1.1A] for its static pressure reset Trim & Respond control loop, low airflow alarms shall be suppressed for that zone.
    b. Low discharge air temperature
        1) If the discharge air temperature is 15°F less than setpoint for 10 minutes, generate a Level 3 alarm.
        2) If the discharge air temperature is 30°F less than setpoint for 10 minutes, generate a Level 2 alarm.
        3) If a zone has an Importance multiplier of 0 [see 1.1A] for its Hot Water reset Trim & Respond control loop, low discharge air temperature alarms shall be suppressed for that zone.
    c. Airflow sensor calibration. If the fan serving the zone has been off for 10 minutes and airflow sensor reading is above 20 CFM, generate a Level 3 alarm.
    d. Leaking damper. If the damper position is 0% for 10 minutes and airflow sensor reading is above 50 CFM while the fan serving the zone is proven on, generate a Level 4 alarm.
    e. Leaking valve. If the valve position is 0% for 15 minutes and discharge air temperature is above AHU SAT by 5°F, generate a Level 4 alarm.
8. Testing/Commissioning Overrides: Provide software switches that interlock to a system level point to
    a. Force zone airflow setpoint to zero
    b. Force zone airflow setpoint to Vcool-max
    c. Force zone airflow setpoint to Vmin
    d. Force zone airflow setpoint to Vheat-max
    e. Force damper full closed/open

f. Force heating to off/closed
g. Reset request-hours accumulator point to zero (provide one point for each reset type listed below)

9. System Requests
   a. Cooling SAT Reset Requests
      1) If the zone temperature exceeds the zone's cooling setpoint by 5°F for 2 minutes and after suppression period due to setpoint change per 1.1A, send 3 Requests,
      2) Else if the zone temperature exceeds the zone's cooling setpoint by 3°F for 2 minutes and after suppression period due to setpoint change per 1.1A, send 2 Requests,
      3) Else if the Cooling Loop is greater than 95%, send 1 Request until the Cooling Loop is less than 85%,
      4) Else if the Cooling Loop is less than 95%, send 0 Requests
   b. Static Pressure Reset Requests
      1) If the measured airflow is less than 50% of setpoint while setpoint is greater than zero for 1 minute, send 3 Requests,
      2) Else if the measured airflow is less than 70% of setpoint while setpoint is greater than zero for 1 minute, send 2 Requests,
      3) Else if the damper position is greater than 95%, send 1 Request until the damper position is less than 85%,
      4) Else if the damper position is less than 95%, send 0 Requests

N. VAV Automatic Fault Detection and Diagnostics
   1. AFDD conditions are evaluated continuously and separately for each operating VAV.
   2. The Operating State (OS) of each VAV shall be defined by the commanded positions of the heating hot water control valve (if present), and volume damper in accordance with the following table and corresponding graphic.

Operating State	Heating Valve Position	Valve Position
#1: Heating	> 0	=> MIN
#2: Deadband	= 0	= MIN
#3: Cooling	= 0	> MIN



3. The following points must be available to the AFDD routines for each VAV:
   a. DAT = Supply air temperature from the VAV box
   b. SAT = Supply air temperature from the AHU
   c. HHWVP = Heating Hot water valve position
   d. AF = VAV AF
   e. DATSP = discharge air temperature setpoint
   f. DSP = duct static pressure
   g. DSPSP = duct static pressure setpoint
   h. AFSP = Air flow setpoint
   i. VAVDP = VAV damper position
4. The following values must be continuously calculated by the AFDD routines for each VAV:
   a. Five minute rolling averages with 1 minute sampling time of the following point values; operator shall have the ability to adjust the averaging window and sampling period for each point independently
      1) DAT_{AVG} = rolling average of discharge air temperature
      2) AF_{AVG} = rolling average of air flow
      3) $HHWVP_{AVG}$ = rolling average of the heating hot water valve position.
      4) $DATSP_{AVG}$ =rolling average of discharge air temperature setpoint
   b. ΔOS = number of changes in Operating State during the previous 60 minutes (moving window)
5. The following internal variables shall be defined for each VAV. All parameters are adjustable by the operator, with initial values as given below:
   a. The default values have been intentionally biased towards minimizing false alarms, if necessary at the expense of missing real alarms. This avoids excessive false alarms that will erode user confidence and responsiveness. These values shall be adjusted based on field measurement and operational experience. Values for

physical factors such as transient loads, and sensor error shall be measured in the field or derived from trend logs.

b. Occupancy delay and switch delays shall be refined by observing in trend data and the time required to achieve quasi steady state operation.

c. Other factors shall be tuned by observing false positives and false negatives (i.e. unreported faults). If transient conditions or noise cause false errors, increase the alarm delay. Likewise, failure to report real faults can be addressed by adjusting the heating coil, temperature, or flow thresholds.

Variable Name	Description	Default Value
ΔT_{MIN}	Minimum difference between SAT (AHU) and DAT to evaluate sensor error conditions (FC#6)	5° F
ε_{DAT}	Temperature error threshold for DAT sensor	2° F
ε_{F}	Airflow error threshold	30%
ε_{CCET}	Cooling coil entering temperature sensor error. Equal to ε_{MAT} or dedicated sensor error	Varies, see Description
ε_{CCLT}	Cooling coil leaving temperature sensor error. Equal to ε_{SAT} or dedicated sensor error	5%
ΔOS_{MAX}	Maximum number of changes in Operating State	7
ModeDelay	Time in minutes to suspend Fault Condition evaluation after a change in Mode	90 60
AlarmDelay	Time in minutes to that a Fault Condition must persist before triggering an alarm	90 60

d. The purpose of ΔT_{MIN} is to ensure that the mixing box/economizer damper tests are meaningful. These tests are based on the relationship between supply, return, and outdoor air. If RAT ≈ MAT, these tests will not be accurate and will produce false alarms.

e. The following are potential Fault Conditions that can be evaluated by the AFDD routines. If the equation statement is true, then the specified fault condition exists. The Fault Conditions to be evaluated at any given time will depend on the Operating State of the AHU.

FC#1	Equation	$DAT > SAT - \varepsilon_{DAT}$ and HHWVP = 0%	Applies to OS #1 – #3
	Description	VAV reheat valve is leaking by heating supply air unnecessarily.	
	Possible Diagnosis	Problem with reheat valve not closing Issues with DAT or SAT sensors.	

FC#2	Equation	AF < AFSP And DSP = DSPSP VAVDP =100%	Applies to OS #1 & #3
	Description	Supply flow is less than setpoint	
	Possible Diagnosis	AF sensor error VAV box damper opening/closing issue High side pitot tube disconnected from AF sensor Reheat coil blockage Issue with AHU DSP sensor Zone Balancing dampers have been closed	
FC#3	Equation	AF > AFSP And VAVDP = 0%	Applies to OS #1 – #3
	Description	Supply flow is greater than setpoint	
	Possible Diagnosis	AF sensor low side pitot tube disconnected from AF sensor VAV box damper opening/closing issue	
FC#4	Equation	DAT<DATSP - ε_{DAT} And HHWVP = 100%	Applies to OS #3
	Description	Reheat is not working	
	Possible Diagnosis	Issue with HHWV HHW system does not have proper DP on the waterside, or is not at operating temperature Reheat coil plugged or isolated. DAT sensor issues. AF too high under heating exceeding coil capacity.	

f. For each VAV, the operator shall be able to suppress the alarm for any Fault Condition.

g. Evaluation of Fault Conditions shall be suspended under the following conditions:
   1) When AHU is not operating.
   2) For a period of Mode Delay minutes following a change in Mode (e.g. from Warm up to Occupied) of any Zone Group served by the AHU.
   3) Fault Conditions that are not applicable to the current Operating State shall not be evaluated.
   4) A Fault Condition that evaluates as true must do so continuously for Alarm Delay minutes before it is reported to the operator.
   5) When a Fault Condition is reported to the operator, it shall be a Level 3 alarm and shall include the description of the fault and the list of possible diagnoses from the table.

6. Plant Requests
   a. Chilled Water Reset Requests

1) If the supply air temperature exceeds the supply air temperature setpoint by 5°F for 2 minutes, send 3 Requests,
2) Else if the supply air temperature exceeds the supply air temperature setpoint by 3°F for 2 minutes, send 2 Requests,
3) Else if the CHW valve position is greater than 95%, send 1 Request until the CHW valve position is less than 85%,
4) Else if the CHW valve position is less than 95%, send 0 Requests

b. Chiller Plant Requests. Send the chiller plant that serves the system a Chiller Plant Request as follows:
1) If the CHW valve position is greater than 95%, send 1 Request until the CHW valve position is less than 10%
2) Else if the CHW valve position is less than 95%, send 0 Requests.

c. If there is a hot water coil, Hot Water Reset Requests
1) If the supply air temperature is 30°F less than setpoint for 5 minutes, send 3 Requests,
2) Else if the supply air temperature is 15°F less than setpoint for 5 minutes, send 2 Requests,
3) Else if HW valve position is greater than 95%, send 1 Request until the HW valve position is less than 85%,
4) Else if the HW valve position is less than 95%, send 0 Requests

d. If there is a hot water coil, Boiler Plant Requests. Send the boiler plant that serves the AHU a Boiler Plant Request as follows:
1) If the HW valve position is greater than 95%, send 1 Request until the HW valve position is less than 10%
2) Else if the HW valve position is less than 95%, send 0 Requests.

O. Chilled Water System
1. General
a. All primary source of chilled water shall be provided by the central plant.
b. BTU monitoring shall be available at the central plant connection to the building.
2. Alarms
a. Static pressure is at least 5 feet head above set-point continuously for 10 minutes.
b. Static pressure is at least 5 feet head below set-point continuously for 5 minutes.

P. Heating Hot Water System
1. General
a. All heating hot water primary pumps shall be provided by boiler manufacturer.
b. Boilers and primary pumps shall be controlled by boiler's internal control manager.
c. BTU monitoring shall be available on the building heating hot water loop near the boilers.
2. Boiler Manager (Provided by the Boiler Manufacturer)
a. Run conditions:
1) The hot water system shall be enabled to run whenever:
a) A definable number of hot water coils need heating.
b) AND the outside air temperature is less than 65^0F.
2) To prevent short cycling, the boiler manager shall run for and be off for minimum adjustable times.
3) The boiler shall run subject to its own internal safeties and controls.
a) Boiler staging – two equal sized hot water boilers running in parallel

4) This section refers to the staging and sequencing of each boiler "train". The sequence of operation for each individual boiler and its associated support equipment (such as pumps) are not included in this section.
5) The boiler manager will determine optimal boiler staging based on manufacturers recommendations for the most efficient parallel boiler control.
6) When a boiler is staged on, the boiler manager shall energize primary pump to run at constant volume, energize boiler, and modulate boiler to maintain discharge temperature.

3. Secondary Lead-Lag pump operation (Provided by the Building Management System Contractor)
   a. The hot water pumps shall operate in lead-lag, switching the lead pump every week.
   b. If the hot water flow rate (as measured at BTU meter) is greater than 47% of design flow rate continuously for 10 minutes, the lag pump shall energize and modulate in parallel with lead pump to maintain operational dp set-point.
   c. If both pumps are running and the flow rate is less than 47% of design flow rate continuously for 10 minutes, the lag pump shall de-energize and the lead pump shall resume normal operation.
   d. Hot water differential pressure operational set-point (Provided by the Building Management System Contractor)
   e. Differential pressure setpoint shall be reset using Trim & Respond logic (see Paragraph 1.1A) with the following parameters. DP-MAX is the design DP setpoint determined in conjunction with the balancing contractor. Refer to specification section 230593.

Variable	Value
Device	Any HW Pump
SP_0	DP-MAX
SP_{min}	1 psi
SP_{max}	DP-MAX
T_d	15 minutes
T	5 minutes
I	2
R	Heating HWDP Reset Requests
SP_{trim}	-2%
SP_{res}	+3%
$SP_{res-max}$	+7%

   f. Hot water pump operation
      1) Lead hot water pump shall modulate to maintain operational dp set-point.
   g. Hot water temperature control
      1) High temperature hot water control valve shall modulate to maintain hot water supply temperature downstream of existing heat exchanger (as measured by hot water supply temp sensor for BTU meter) at 180 deg F.
   h. Alarms
      1) Static pressure is at least 5 feet above set-point continuously for 15 minutes.
      2) Static pressure is at least 5 feet below set-point continuously for 15 minutes.
      3) Hot water supply greater than 15^0F above set-point.

4) Hot water supply less than 15^0F above set-point.

Q. Boiler System Automatic Fault Detection and Diagnostics
1. AFDD conditions are evaluated continuously and separately for each operating Boilers.
2. The Operating State (OS) of each Boiler shall be defined as enabled or disable with producing HHW at setpoint within 10°F.
3. The following points must be available to the AFDD routines for the boiler and the system:
   a. HHWST = Heating Hot water supply temperature
   b. HHWSTSP = HHW supply temperature setpoint
   c. HHWDP = HHW differential pressure
   d. HHWDP SP = HHW differential pressure setpoint
   e. HHW P-1SC = HHWP-1 Speed
   f. HHW P-1SC = HHWP-2 Speed
   g. HHWRT = Heating hot water return temp
   h. B-1S = Boiler 1 status
   i. B-2S = Boiler 2 status
4. The following values must be continuously calculated by the AFDD routines for each VAV:
   a. Five minute rolling averages with 1 minute sampling time of the following point values; operator shall have the ability to adjust the averaging window and sampling period for each point independently
      1) $HHWST_{AVG}$ = rolling average of HHW supply water temperature
      2) $HHWDP_{AVG}$ = rolling average of HHW Differential Pressure
   b. ΔOS = number of changes in Operating State during the previous 60 minutes (moving window)
5. The following internal variables shall be defined for each Boiler and secondary HHWP. All parameters are adjustable by the operator, with initial values as given below:
   a. The default values have been intentionally biased towards minimizing false alarms, if necessary at the expense of missing real alarms. This avoids excessive false alarms that will erode user confidence and responsiveness. These values shall be adjusted based on field measurement and operational experience. Values for physical factors such as transient loads, and sensor error shall be measured in the field or derived from trend logs.
   b. Occupancy delay and switch delays shall be refined by observing in trend data and the time required to achieve quasi steady state operation.
   c. Other factors shall be tuned by observing false positives and false negatives (i.e. unreported faults). If transient conditions or noise cause false errors, increase the alarm delay. Likewise, failure to report real faults can be addressed by adjusting the heating coil, temperature, or flow thresholds.

Variable Name	Description	Default Value
ΔOS_{MAX}	Maximum number of changes in Operating State	7
ModeDelay	Time in minutes to suspend Fault Condition evaluation after a change in Mode	90 60
AlarmDelay	Time in minutes to that a Fault Condition must persist before triggering an alarm	90 60

Variable Name	Description	Default Value

d. The purpose of ΔT_{MIN} is to ensure that the mixing box/economizer damper tests are meaningful. These tests are based on the relationship between supply, return, and outdoor air. If RAT ≈ MAT, these tests will not be accurate and will produce false alarms.

e. The following are potential Fault Conditions that can be evaluated by the AFDD routines. If the equation statement is true, then the specified fault condition exists. The Fault Conditions to be evaluated at any given time will depend on the Operating State of the AHU.

FC#1	Equation	HHWST < or > HHWSP (greater than 5°F difference and Boilers and pumps are enabled
	Description	Boiler not operating at setpoint temperature
	Possible Diagnosis	Issue with the enabled boiler Primary flow too low. Primary flow too high Not enough boilers enabled Too many boilers enabled.
FC#2	Equation	Boiler enables and disables in less than 10 minutes time
	Description	Rapid cycling of boilers
	Possible Diagnosis	Low delta T of HHW Too many boilers enabled or allowed to ramp firing rate to fast.
FC#3	Equation	HHWDP>HHWDPSP
	Description	HHW DP is to high compared to setpoint
	Possible Diagnosis	Lag pump is not disabled when it should. Pump minimum speed must be lowered All Control valves are closed (system should be disabled.
FC#4	Equation	HHWDP<HHWDPSP
	Description	HHW DP not enough
	Possible Diagnosis	HHWP not staging up. Strainers clogged in the system Check pressure drops Issues with pumps or VFD's.

f. For each Boilers or pumps, the operator shall be able to suppress the alarm for any Fault Condition.

g. Evaluation of Fault Conditions shall be suspended under the following conditions:

1) When AHU is not operating.
2) For a period of Mode Delay minutes following a change in Mode (e.g. from Warm up to Occupied) of any Zone Group served by the AHU.
3) Fault Conditions that are not applicable to the current Operating State shall not be evaluated.
4) A Fault Condition that evaluates as true must do so continuously for Alarm Delay minutes before it is reported to the operator.
5) When a Fault Condition is reported to the operator, it shall be a Level 3 alarm and shall include the description of the fault and the list of possible diagnoses from the table.

R. Testing/Commissioning Overrides: Provide software switches that interlock to a chilled water and hot water plant level to
1. Force chilled water valve full open
2. Force chilled water valve full closed

S. Exhaust Fan Control Enable/Disable
1. All exhaust fans serving the 1st floor shall be enabled when AHU-1 is proved on and disabled when AHU-1 is proved off.
2. All exhaust fans serving the 2nd floor shall be enabled when AHU-2 is proven on and disabled when AHU-1 is proved off.
3. Speed Control
   a. While fan is energized, motor shall run at constant volume.

T. Split System Heat Pump Control
1. General
   a. Split systems shall be controlled by standalone packaged controls and monitored by the BAS.
2. Enable/Disable
   a. Split systems shall always be enabled.
3. Temperature control
   a. Split systems shall use packaged controls to maintain space cooling setpoints.
4. Alarms
   a. Zone temperature is 15% greater than set-point continuously for 10 minutes.
   b. Zone temperature is 15% less than set-point continuously for 10 minutes.

U. Flow Meter / Energy Meter FDD
1. General
   a. Prior to enabling systems I.E. fan or boiler systems with valves closed system flow shall be checked for zero flow and alarmed if flow is greater than 5% of total flow range is shown when no flow is possible.
   b. Without operating the fans or boilers open all the valves 100% while any dampers are closed and pumps operating at 75% verify any temperature sensors are reading outside of each other by 3°F. Alarm to manually verify with calibrated hand-held sensor the highest reading with the lowest reading. Any sensor reading 1°F from offset should be calibrated.

2.3 BUILDING REPORTS

A. Provide year-around scheduling incorporating school holidays and vacations as provided by the Owner.

B. Annunciation of events and occurrences on three levels: routine maintenance, low-level alarm condition; high-level alarm condition.
   1. Maintenance alarms shall annunciate conditions that require routine maintenance, such as dirty filters, or hours of equipment operation reaching elapsed time for scheduled preventive maintenance.
   2. Low-level alarm shall annunciate conditions which reflect inoperability of equipment that would not prevent the HVAC systems from providing service but requires maintenance or repair to re-establish operation such as a failed pump or filter alarm.
   3. High-level alarms shall annunciate conditions which require immediate response in order to insure provision of building HVAC, or that reflect a catastrophic failure of equipment.
   4. Contractor shall submit to the Engineer for review and approval designation of all conditions for annunciation. All equipment shall be monitored for elapsed time between inspection and service; all status of inoperability shall be monitored; all alarm conditions as indicted in this Section shall be monitored by the DDC system. All conditions as indicated herein shall annunciate via overriding screen display; display and output shall be submitted for review and approval.

2.4 HISTORY AND TRENDING.

A. All control points shall be recorded in intervals no shorter than 15 minutes. These recordings shall be exportable to a CSV file using a user selected time window.

B. Where zone data (such as damper or valve position, control loop signal) is used for reset of the AHU system serving the zone, the zone tag (name) shall be recorded when it is the zone driving the reset (such as the zone requiring the most cooling). This data shall be available for reports so that the zones that are undersized or otherwise driving the system can be identified for remediation if required.

END OF SECTION 230993

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:
   1. Hot-water heating piping.
   2. Chilled-water piping.
   3. Condensate-drain piping.
   4. Air-vent piping.
   5. Safety relief valve inlet and outlet piping.

B. See Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Pressure-seal fittings.

B. Delegated-Design Submittal:
   1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
   2. Locations of pipe anchors and alignment guides and expansion joints and loops.
   3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
   4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

E. Operation and maintenance data.

1.5 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 Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
   2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

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

D. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
   2. 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. Wrought-Copper Unions: ASME B16.22.
   1. 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:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elkhart
      b. Mueller
      c. Nibco
      d. Or equal

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

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

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

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Capitol Manufacturing Company.
   b. Hart Industries International, Inc.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   d. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
   e. Or equal

3. Description:
   a. Standard: ASSE 1079.
   b. Pressure Rating: 150 psig minimum at 210 deg F.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Calpico, Inc.
   b. Lochinvar Corporation.
   c. Or equal
   d. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 150-psig minimum working pressure at 210 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be one the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

B. Chilled-water piping, aboveground, NPS 2 and smaller, shall be one the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

C. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be one the following:
   1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

D. Condensate-Drain Piping: Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

E. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
   2. Outlet: Type L, annealed-temper copper tubing with 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 piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

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

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

C. Install piping 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 with adequate space to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

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

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install manual air vents at all high points on piping 2" and smaller.

N. Install automatic air vents at all high points on piping 2.5" or larger. Pipe vent to nearest drain with adequate slope to completely drain line.

O. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

P. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

Q. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

R. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

S. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

T. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

U. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS ¾" nipple and ball valve in blowdown connection of strainers NPS 2" and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2".

V. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

W. Install sleeves for piping penetrations of walls, ceilings, and floors.

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 7 feet.
   2. NPS 1: Maximum span, 7 feet.
   3. NPS 1-1/2: Maximum span, 9 feet.
   4. NPS 2: Maximum span, 10 feet.
   5. NPS 2-1/2: Maximum span, 11 feet.
   6. NPS 3 and Larger: Maximum span, 12 feet.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.4 PIPE JOINT CONSTRUCTION

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

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

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

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

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

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

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

H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.6 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 not less than 1.5 times the system's working pressure. 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 the "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.
6. Prepare written report of testing.

C. Perform the following before operating the system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232114 - UNDERGROUND HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Underground pre-insulated plastic pipes and fittings.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:
   1. Heating Hot Water Piping: 150 psig at 200 deg F.
   2. Chilled Water Piping: 125 psig at 100 deg F.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. All piping data. Submit data indicating that pipe, tube and fittings are manufactured exclusively in North America, Germany or Italy.

B. Shop Drawings: For underground hydronic piping. Signed and sealed by a professional engineer.
   1. Calculate requirements for expansion compensation for underground piping.
   2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement in the required locations. Show anchors and guides that restrain piping movement with calculated loads.
   3. Show pipe sizes, locations, and elevations. Show piping in trench, conduit, and cased pipe with details showing clearances between piping, and show insulation thickness.
   4. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the pipe vault structure.
   5. Show locations of pipe anchors and alignment guides and expansion joints and loops.

1.5 INFORMATIONAL SUBMITTALS

A. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and at vertical scale of not less than 1 inch equals 5 feet. Indicate

manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing hydronic piping.

B. Qualification Data: For qualified Installer.

C. Material Test Reports: For piping.

D. Source quality-control reports.

E. Field quality-control reports.

F. Butt fusion welding joint reports.

G. HDPE fusion welded joint kit reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with provisions in ASME B31.9, "Building Services Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:
   1. Chilled Water Piping: 125 psig at 100 deg F.
   2. Air-vent piping: match performance of connected pipe.

2.2 HIGH DENSITY POLYETHYLENE PIPES AND FITTINGS

A. Description: Factory-fabricated piping with carrier pipe, insulation, and casing. All pre-insulated pipe, fittings, insulating materials, and technical support shall be provided by the pre-insulated piping system manufacturer.

B. Manufacturers:
   1. Thermocor Process Inc. Ferro-Therm
   2. Perma-Pipe
   3. Urecon

C. Carrier Pipe:

1. HDPE SDR 13.5 conforming to ASTM D-3350 and AWWA C906 and using PE3408/PE3608 resin. Pipe and fittings are manufactured from extra high molecular weight polyethylene compound and fabricated to Standard Dimensional Ratio (SDR 13.5) wall thickness in standard IPS sizes.
2. Method of Pipe Connection: Fusion-welded HDPE SDR 13.5.

D. Casing: HDPE having a wall thickness of not less than 135 mils for pipe sizes less than or equal to 14" and 165 mils for jacket sizes larger than 14" to 20". The inner surface of the HDPE jacket shall be oxidized by means of corona treatment, flame treatment, or other approved methods to ensure a secure bond between the jacket and foam insulation preventing any ingression of water at the jacket / foam interface.

E. Carrier Pipe Insulation:
1. Polyurethane Foam Pipe Insulation: Rigid, cellular, spray applied to the carrier pipe.
   a. Comply with ASTM C 591; thermal conductivity (k-value) shall not exceed 0.16 BTU x in/h x sq. ft. x deg F at 75 deg F after 180 days of aging aging or to EN253 with lambda value not exceeding 0.0241W/m*K
   b. Insulation shall have a minimum density of 2lb/ft^3 and shall be a minimum 90% closed cell in structure.

F. Straight Run Joints: Shall be butt fusion welded.

G. Carrier Pipe Fittings:
1. Shall be butt fusion-welded to adjacent pipe sections and shall be constructed to meet ASTM D3261 and AWWA C906.
2. Molded and fabricated fittings shall have a pressure rating equal to the pipe.
3. Fittings that are butt fusion welded in the field shall be insulated. End seals at uninsulated fittings shall be field-applied mastic moisture barriers. Factory manufactured fittings shall be pre-insulated using factory PE fitting covers welded to the jackets.
4. The critical parameters of each fusion joint shall be recorded by an electronic data logging device and included in a report at the end of the job.

H. Plastic, Pipe-Flange Gasket, Bolts, and Nuts:
1. Flanges and Mechanical Joint Adapters shall have a material designation code of PE3608 or higher. Flanged and Mechanical Joint Adapters can be made to ASTM D3261 or if machined, must meet the requirements of ASTM F2206. Flanges and MJ Adapters shall have a pressure rating equal to the pipe.
2. Van-Stone style, metallic, convoluted or flat-plate, back-up rings and bolt materials shall have bolt holes and bolt circles conforming to AME B-16.1 Class 125. The back-up ring shall provide a long term pressure rating equal to or greater than the pressure-class of the pipe with which the flange adapter assembly will be used. The back-up ring, bolts and nuts shall be protected from corrosion by the same methodology used to protect valves as depicted in 230523 "General Duty Valves for HVAC Piping".

PART 3 - EXECUTION

3.1 EARTHWORK

A. See Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATION

A. Chilled-Water Piping:

1. NPS 2-1/2 and larger shall be the following:

a. Chilled water supply piping shall be HDPE SDR 13.5 factory pre-insulated with polyurethane carrier-pipe insulation. Where indicated on the Drawings in order to tie into existing PVC pipfing systems Pre-Insulated PVC Piping Systems shall be used, piping shall be C900.
   1) Piping Insulation Thickness: 1.5 inches.

b. Buried chilled water return piping shall be uninsulated HDPE SDR 13.5. Where indicated on the Drawings in order to tie into existing PVC piping systems PVC Piping shall be used, piping shall be C900.

3.3 PIPING INSTALLATION

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. Remove standing water in the bottom of trench.

C. Do not backfill piping trench until field quality-control testing has been completed and results approved.

D. Install piping at uniform grade of 0.2 percent. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points and elsewhere as required for system drainage. Install manual air vents at high points.

E. In conduits, install drain valves at low points and manual air vents at high points.

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

G. Install piping free of sags and bends.

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

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs for HDPE and steel pipe. Bevel plain ends of steel pipe.

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

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

D. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

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

F. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

G. Conduit and Cased Piping Joints: Assemble sections and finish joints with pourable insulation and exterior jacket sleeve, and apply fusion welded seals (shrink-wrap seals are allowable where dictated in Chapter 2).

H. Butt Fusion: The pipe shall be joined by the butt fusion process outlined in ASTM F2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made per qualified technicians per PPI TN-42.

I. Butt Fusion joint recording: The critical parameters of each fusion joint shall be recorded by an electronic data logging device. All fusion joint data shall be included in a Fusion Technician's joint report.

3.5 IDENTIFICATION

A. Install continuous plastic underground warning tapes during back filling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches below finished grade, directly over piping. See Section 312000 "Earth Moving" for warning-tape materials and devices and their installation.

3.6 FIELD QUALITY CONTROL

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

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

C. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
   1. Prepare hydronic piping for testing according to ASME B31.9 and as follows:
      a. Leave joints, including welds, uninsulated and exposed for examination during test.
      b. Fill system with water. Where there is risk of freezing, air or a safe, compatible liquid may be used.
      c. Use vents installed at high points to release trapped air while filling system.
   2. Test hydronic piping as follows:
      a. Subject hydronic piping to hydrostatic test pressure that is not less than 100 PSI for chilled water.
      b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
      c. After no leaks appear to exist, test pipe for 12 hours. Repeat item b. above if leaks are found.
   3. Test conduit as follows:
      a. Seal vents and drains and subject conduit to 15 psig for four hours with no loss of pressure. Repair leaks and retest as required.

E. Prepare test and inspection reports.

END OF SECTION 232114

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes special-duty valves and specialties for the following:
   1. Hot-water heating piping.
   2. Chilled-water piping.
   3. Makeup-water piping.
   4. Condensate-drain piping.
   5. Safety relief valve inlet and outlet piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   2. Air-control devices.
   3. Hydronic specialties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
   1. Hot-Water Heating Piping: 150 psig at 200 deg F.
   2. Chilled-Water Piping: 150 psig at 200 deg F.
   3. Makeup-Water Piping: 80 psig at 150 deg F.
   4. Condensate-Drain Piping: 150 deg F.
   5. Blowdown-Drain Piping: 200 deg F.
   6. Air-Vent Piping: 200 deg F.
   7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," Section 230523.14 "Check Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230923.11 "Control Valves."Section 15901 "Control Valves."

C. Bronze, Calibrated-Orifice, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong Pumps, Inc.
      b. Taco.
      c. Bell & Gossett.
      d. Or equal
   2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
   3. Ball: Brass or stainless steel.
   4. Plug: Resin.
   5. Seat: PTFE.
   6. End Connections: Threaded or socket.
   7. Pressure 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.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong Pumps, Inc.
      b. Taco.
      c. Bell & Gossett.
      d. Or equal

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.

E. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Spence Engineering Company, Inc.
   c. Watts; a Watts Water Technologies company.
   d. Or equal
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: 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.

F. Diaphragm-Operated Safety Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett; a Xylem brand.
   c. Watts; a Watts Water Technologies company.
   d. Or equal
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: 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.

G. Flow Metering Station:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. RWV Metering Station Model 9407
   b. Or equal by Griswold Controls.
2. Body Style: Venturi Insert.
3. Autoflow valves are NOT acceptable.
4. Identification Tag: Marked with zone identification,
5. Size: Same as pipe in which installed.
6. Performance: Minimum CWP Rating: 300PSIG WOG.
7. Maximum Operating Temperature: 200 deg F .

2.3 AIR-CONTROL DEVICES

A. Manual Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett; a Xylem brand.
   c. Taco, Inc.
   d. Or equal.
2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett; a Xylem brand.
   c. Taco, Inc.
   d. Or equal
2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/4.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

C. Bladder-Type Expansion Tanks:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett; a Xylem brand.
   c. Taco, Inc.
   d. Or equal

2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. Tangential-Type Air Separators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Spirotherm
   b. Armstrong Pumps, Inc.
   c. Or equal
2. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
3. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
4. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
5. Blowdown Connection: Threaded.
6. Size: Match system flow capacity.

E. In-Line Air Separators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Spirotherm
   b. Armstrong Products, Inc.
   c. Bell & Gossett; a Xylem brand.
   d. Taco, Inc.
   e. Or equal
2. Separator Tank:
   a. Vessel shall be fabricated steel, stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels, and include two equal chambers above and below the inlet / outlet nozzles.
   b. The vessel diameter and height above and below the inlet / outlet connections must be equal to the basis of design. Unit shall include internal elements filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location.
   c. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes. The elements must consist of a copper core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed.
   d. Each unit shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.
   e. Units shall include a side tap with valve to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.
3. Maximum Working Pressure: Up to 150 psig.
4. Maximum Operating Temperature: Up to 300 deg F.

2.4 BUFFER TANK

A. Heating Hot Water Decoupler/Buffer Tank
   1. Provide the size and capacity indicated on the floor plans
   2. Interior: Unpainted.
   3. Exterior: Prime Coat
   4. Rating: ASME Section VIII, 'U' STAMPED
   5. Maximum Operating Temperature: 250 Degrees F
   6. Maximum Working Pressure: 150 PSIG
   7. Tolerance: ± 1/4"
   8. Provide sensor port in the side of the tank and 2" drain with plug in the bottom of tank.

2.5 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: Stainless-steel, 40-mesh strainer, or perforated stainless-steel basket.
   4. CWP Rating: 125 psig .

B. Stainless-Steel Bellow, Flexible Connectors:
   1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
   2. End Connections: Threaded or flanged to match equipment connected.
   3. Performance: Capable of 3/4-inch misalignment.
   4. CWP Rating: 150 psig.
   5. Maximum Operating Temperature: 250 deg F.

C. Spherical, Rubber, Flexible Connectors:
   1. Body: Fiber-reinforced rubber body.
   2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
   3. Performance: Capable of misalignment.
   4. CWP Rating: 150 psig.
   5. Maximum Operating Temperature: 250 deg F.

D. Expansion Fittings: Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

E. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

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SECTION 232123 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:
   1. Close-coupled, in-line centrifugal pumps.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
   1. "No Exception Taken".
   2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

C. Shop Drawings: For each pump.
   1. Show pump layout and connections.
   2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Mechanical Seals: One mechanical seal for each pump.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
   1. Peerless Pumps
   2. Armstrong Pumps, Inc.
   3. ITT Corporation; Bell & Gossett.
   4. Paco Pumps.
   5. Or equal

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.

C. Pump Construction:
   1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
   2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
   3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
   4. Seal: Packing seal consisting of 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.
   5. Pump Bearings: Permanently lubricated ball bearings.

D. Motor: Single speed and rigidly mounted to pump casing.
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      a. Enclosure: Totally enclosed, fan cooled.
      b. Enclosure Materials: Cast iron].
      c. Motor Bearings: Permanently lubricated up through 5 HP. Grease-lubricated ball bearings for larger motor sizes.
      d. Efficiency: Premium efficient.
      e. NEMA Design: A.
      f. Service Factor: 1.15.
      g. Shaft Grounding: On all variable speed driven motors.

E. Capacities and Characteristics:
   1. Refer to Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all pumps before installation. Reject pumps that are damaged.

B. Before pump installation, examine:
   1. Equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   2. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
   3. Final pump locations indicated on Drawings are diagrammatic and approximate. Determine exact locations before roughing-in for piping and electrical connections.

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

3.2 PUMP INSTALLATION

A. Comply with HI 1.4 and HI 2.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for 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 and shutoff valves on discharge side of pumps.

F. Install strainer or suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or

install single gage with multiple-input selector valve.

3.4 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.
   4. Perform the following startup checks for each pump before starting:
      a. Verify bearing lubrication.
      b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
      c. Verify that pump is rotating in the correct direction.
   5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
   6. Start motor.
   7. Open discharge valve slowly.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

3.6 WARRANTY

A. Provide 2 year warranty

END OF SECTION 232123

SECTION 232513 – PASSIVATION FOR CHILLED AND HOT WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 and Section 23 0000 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following water treatment for closed-loop hydronic systems:
   1. This pre-treatment procedure for cleaning and passivation of chilled and heating hot water piping is to be used when new chilled/heating water systems and/or copper coils are installed in existing or new buildings to ensure the water-contacted equipment is protected from corrosion and deposits.
   2. All testing should be performed by air (inert gas) whenever possible to avoid the use of Hydro testing which at such point will require contractor to adhere to the below Cleaning and Passivation requirements.
   3. Coordination of drain and refill locations complete with shut off valves of the system with the Mechanical Contractor locations.
   4. Coordination with the College's HVAC Water-Treatment Service Provider who will be responsible to provide the chemicals for the FINAL water treatment system fill.

1.3 DEFINITIONS

A. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

B. MSDS: Material Safety Data Sheets.

1.4 REGULATORY REQUIREMENTS

A. Conform to all applicable codes for non-potable chemicals to be used for HVAC Water Treatment.

B. All chemicals shall be suitable to be drained to the public sanitary sewer system.

1.5 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
   1. Temporary injection and circulation pumps.
   2. Chemical test kits and equipment.
   3. Pre-treatment Cleaning and Passivation Chemical list with MSDS.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to hydronic systems.
   1. Include plans with proposed locations for drain down and fill points.
   2. Schematic diagrams indicating pump location to circulate (supply and return) chemical pre-treatment.
   3. Include diagrams for power and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

B. Field quality-control reports.

C. Other Informational Submittals:
   1. Water Analysis: Illustrate water quality available at Project site.

1.7 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. HVAC Water-Treatment Service Provider shall be capable of providing 10 years of documented experience if requested.

1.8 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
   1. Initial HVAC water-treatment recommendations for cleaning and passivation.
   2. Startup assistance for Contractor to flush, pre-treat and clean the pipe to prepare it for passivation.
   3. Passivation of piping prior to initially fill and operation of the system with required water chemical treatment.
   4. NOTE: Final fill water treatment chemical shall be provided by the College.
   5. Customer report charts and log sheets.
   6. Laboratory technical analysis.
   7. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Santa Ana College current water treatment provider.

B. Or Approved Equal

2.2 PERFORMANCE REQUIREMENTS

A. Water treatment to chemically flush and clean remove the loose rust, dislodging the burrs, welding slag and mill scales adhering to the internal surface of the pipe and left behind from the installation of the piping. A minimum of 5ft/s in the largest main shall be attained during the flushing process.

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.

2.3 CHEMICALS

A. All chemicals and cleaners used shall NOT contain any ammonia based chemicals, nor any phosphates or phosphorous-based chemicals.

B. Circulating Water Applications
   1. Pre-treatment Clean and Flush
      a. Neutral pH product to maintain a pH of 7.0-8.0 in the new piping and coil system. It should not contain any ammonia or phosphate products.
      b. Or approved equal
   2. Passivator
      a. Chilled Water
         1) pH 8.5 to 10.5
         2) Molybdate at 400 ppm +/- 100-120 ppm
         3) Azole at 40 ppm +/- 10-20 ppm
      b. Hot Water
         1) pH 8.5 to 10.5
         2) Sodium Nitrite 1,000-1200ppm
         1) Azole at 40 ppm +/- 10-20 ppm
   3. Inhibitor
      a. Molybdenum based closed circuit corrosion and scale inhibitor

2.4 TEMPORARY CHEMICAL-FEED EQUIPMENT

A. Provide temporary chemical feed equipment separate from the existing central plant, arrangement of pumps, piping, valves tanks etc. as required to introduce cleaning, degreasing and inhibitors for passivation of the piping system.

2.5 CHEMICALS TEST EQUIPMENT AND REAGENTS

A. Chemicals test equipment and reagents shall be as recommended by HVAC Water-Treatment Service Provider 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 GENERAL REQUIREMENTS:

A. Prior to any chemical water treatment of passivation measures, contact RSCCD Facilities Management HVAC Shop to confirm campus requirements for passivation. Any specific Owner requirements and instructions for passivation measures shall supersede this specification section.

B. If the system and/or coils are hydrotested before being cleaned and passivated, the hydrotest water shall be city water or its equivalent, and the system and/or coils shall not remain filled and stagnant for more than seven (3) days prior to cleaning and passivation.

C. During each step of this procedure, water samples shall be taken and a written report made identifying the name and amount of chemical added, the date and time the chemical was added, the length of time the water was circulated, the date and time the system was flushed, and the date and time the system was tied into the campus TES chilled water or heating hot water system.

3.2 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

B. Water samples taken during each step shall be analyzed, at least, for the pH, conductivity, copper, iron, total alkalinity, phosphate, total hardness, and chlorides. Additional tests shall be taken as noted in this procedure.

3.3 PREPARATION

A. Hydronic piping test for leaks and defects shall be completed prior to the HVAC water treatment is to begin. If testing is performed in segments, submit separate pressure test report for each segment, complete with diagram of portion of piping tested.

B. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

C. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

D. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

E. Repair leaks and defects with new materials and retest piping until no leaks exist.

3.4 INSTALLATION

A. Install in accordance with the HVAC Water Treatment Providers recommendations.

B. Coordinate with the Mechanical Contractor the configuration of the temporary chemical feed equipment for the chemical cleaning and passivation.

C. All chemicals shall be introduced to the system through a temporary bypass feeder as required by testing.

D. Coordinate with the Mechanical Contractor any temporary power requirements.

E. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Provide general-duty butterfly or ball valves are specified in Section 230523. Provide threaded connection on the inlet and outlet with caps

F. The temporary system shall be operational, filled, started and vented prior to cleaning.

G. Mechanical Contractor shall coordinate with the College's representative and the College's existing HVAC Water-Treatment Service Provider to schedule the water treatment and final fill requirements.

3.5 CONNECTIONS

A. Where installing piping adjacent to piping equipment, allow space for access to safely operate the system during the initial clean and passivation.

B. Provide piping connections and shut-off valves between HVAC water-treatment equipment and the piping to allow for the circulation of the water treatment at minimum of 5 FPS velocities.

C. Provide backflow preventers as required for makeup-water connections to potable-water systems.

3.6 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections
   1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
   2. Inspect piping and equipment to determine that systems and equipment are fully operational before introducing chemicals for water-treatment system.

C. Equipment will be considered defective if it does not pass tests and inspections.

3.7 CLEANING SEQUENCE

A. This step should be done within 24 hour of the disinfection procedure.

B. Isolate existing piping from new piping so as to circulate solution in the newly installed pipe system ONLY.

C. Contractor shall provide valves and piping as necessary to bypass the existing water systems.

D. Add sufficient neutral-based cleaner, as recommended by the manufacturer, to the system and/or coils water, and circulate for 24-36 hours at full flow.

E. Drain and refill and flush the system with city water for at least one (1) hour or until the rinse water is clean of any particulates or oil. Continue the flushing procedure until the water is equivalent to city water.

F. At the end of the cleaning, take and analyze water samples as noted in the notes section above.

3.8 PASSIVATION

A. Start passivation at the end of the cleaning cycle, but no longer than six (6) hours later.

B. Add the passivation chemical to the system and circulate for six (6) hours, but test after two (2) hours for molybdate and azole levels to ensure the required levels are reached, as shown in the notes section above. If the levels are below the required levels, then add additional chemicals and retest in another two (2) hours. Repeat until the proper levels are reached. Once the proper levels are reached, circulate for six (6) hours.

C. At the end of passivation, take and test water samples for the molybdate and azole levels.

D. Once approved, the new system and/or coils may be tied into the campus TES chilled water and/or heating hot water system.

E. RECORDS MANAGEMENT:
   1. A copy of this procedure shall be kept in the Procedures Manual maintained by the FM Director's Assistant.

END OF SECTION 232513

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SECTION 232514 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

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PART 1 - GENERAL

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1.1 RELATED DOCUMENTS

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

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To view non-printing **Editor's Notes** that provide guidance for editing, click on Masterworks/Single-File Formatting/Toggle/Editor's Notes.¶

To read **detailed research, technical information about products and materials, and coordination checklists,** click on Masterworks/Supporting Information.¶

1.2 SUMMARY

A. Section includes the following water treatment for closed-loop hydronic systems:
   1. Automatic chemical-feed equipment.
   2. Chemicals.

1.3 DEFINITIONS

Deleted: <#>Related Requirements:¶
<#>Section 232533 "HVAC Makeup-Water Filtration Equipment" for water softeners, RO equipment, and filtratio equipment.¶

A. 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.

B. RO: Reverse osmosis.

C. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

D. MSDS: Material Safety Data Sheets.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
   1. Bypass feeders.
   2. Water meters.
   3. Inhibitor injection timers.
   4. pH controllers.
   5. TSS controllers.
   6. Chemical solution tanks.
   7. Injection pumps.
   8. Chemical test equipment.
   9. Chemical MSDS.

Deleted: material safety data sheets

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to hydronic systems.
   1. Include plans, elevations, sections, and attachment details.
   2. Include diagrams for power, signal, and control wiring.

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(Client Project Number) . (P2S Project Number)¶

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For components, from manufacturer. (Not needed if provided by SEOR)
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Field quality-control reports.

D. Other Informational Submittals:
   1. Water-Treatment Program: Written sequence of operation on an annual basis for the application and equipment required to achieve water quality defined in "Performance Requirements" Article.
   2. Water Analysis: Illustrate water quality available at Project site.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.7 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. HVAC Water-Treatment Service Provider shall provide 10 years of documented experience if requested.

1.8 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
   1. Initial water analysis and HVAC water-treatment recommendations.
   2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
   3. Periodic field service and consultation.
   4. Customer report charts and log sheets.
   5. Laboratory technical analysis.

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6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Santa Ana College current water treatment provider.

B. Or Approved Equal

2.2 PERFORMANCE REQUIREMENTS

A. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.

B. The water treatment program shall include:
   1. Pre-treatment clean and flush
   2. Passivation
   3. Inhibitor
   4. For remodel project where only a portion of the building is being renovate, the new supply and return piping shall be isolated from the rest of the facility, pre-treated and flushed and passivated. Once passivation is complete the new piping shall be opened to the existing facility loop to be treated with inhibitor.
      a. Provide temporary chemical feed equipment, piping, valves tanks etc. as required to introduce cleaning, degreasing and chemicals for passivation of the piping system.
      b. Provide temporary pump to circulate the water at a minimum of 5 feet per second.
      c. Coordinate supply and return point of connections indicated on the plans with the mechanical contractor.

C. Design HVAC water treatment program on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

D. Closed hydronic systems, including hot-water heating, 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. TSS: Maintain a maximum value of 10 ppm.
   7. Ammonia: Maintain a maximum value of 20 ppm.
   8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
   9. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
      b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.

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c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
1. Capacity: 5 gal..
2. Minimum Working Pressure: 125 psig.

2.4 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter:
1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 150 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons.
6. End Connections: Threaded.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.
8. 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. Water Meter:
1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 100 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons.
6. End Connections: Threaded.
7. Control: Low-voltage signal capable of transmitting 1000 feet.
8. 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. Water Meter:
1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 150 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons.
6. End Connections: Flanged.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.

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8. 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. Chemical Solution Tanks:
1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: 30 gal.

E. Chemical Solution Injection Pumps:
1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

G. Injection Assembly:
1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: Two-piece, stainless steel; selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

2.5 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.

B. All chemicals and cleaners used shall NOT contain any ammonia based chemicals, nor any phosphates or phosphorous-based chemicals.
1. Pre-treatment Clean and Flush
   a. Neutral pH product to maintain a pH of 7.0-8.0 in the new piping and coil system. It should not contain any ammonia or phosphate products.
   b. Or approved equal
2. Passivator
   a. Chilled Water
      1) pH 8.5 to 10.5
      2) Nitrite at 1,000-1200 ppm
      3) Molybdate at 400 ppm +/- 100-120 ppm

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4) Azole at 40 ppm +/- 10-20 ppm
5) Or approved equal

b. Hot Water

1) pH 8.5 to 10.5
2) Sodium Nitrite 1,000-1200ppm
4) Azole at 40 ppm +/- 10-20 ppm
5) Or approved equal

3. Inhibitor

a. Nitrite based closed circuit corrosion and scale inhibitor

C. If tied into a TES system, use molybdenum based closed circuit corrosion and scale inhibitor

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to any chemical water treatment or passivation measures, contact RSCCD District's Facilities Management to confirm campus requirements for passivation. Any specific Owner requirements and instructions for passivation measures shall supersede this specification section.

B. If the system is hydrotested before being cleaned and passivated, the hydrotest water shall be city water or its equivalent, and the system and/or coils shall not remain filled and stagnant for more than seven (3) days prior to cleaning and passivation.

3.2 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

B. Water samples taken during each step shall be analyzed, at least, for the pH, conductivity, copper, iron, total alkalinity, phosphate, total hardness, and chlorides. Additional tests shall be taken as noted in this procedure.

3.3 PREPARATION

A. Hydronic piping test for leaks and defects shall be completed prior to the HVAC water treatment is to begin. If testing is performed in segments, submit separate pressure test report for each segment, complete with diagram of portion of piping tested.

B. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

3.4 INSTALLATION

A. Install in accordance with the HVAC Water Treatment Providers recommendations.
1. Temporary Circulation Pumps

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a. Coordinate with the Mechanical Contractor the configuration of any temporary pumps, chemical feed equipment, valves and piping for the chemical cleaning and passivation.
b. Provide pumps, piping connections and shut-off valves between HVAC water-treatment equipment and the piping to allow for the circulation of the water treatment at minimum of 5 FPS velocities.
c. Provide backflow preventers as required for temporary makeup-water fill connections to potable-water systems.
d. The temporary system shall be operational, filled, started and vented prior to cleaning.
e. Mechanical Contractor shall coordinate with the College's representative and the College's existing HVAC Water-Treatment Service Provider to schedule the water treatment and final fill requirements.

B. Install chemical treatment equipment on 4" thick minimum concrete housekeeping pads, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. (ref 033000 Cast In Place Concrete)

C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Provide general-duty ball valves as specified in Section 230523.(or 230523.12 Ball Valves) Provide threaded connection on the inlet and outlet with plugs

D. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

E. Install water testing equipment on wall near water chemical application equipment.

F. Install interconnecting control wiring for chemical treatment controls and sensors.

G. Mount sensors and injectors in piping circuits. Coordinate with mechanical contractor.

H.

I. coordinate with electrical contractor for power to chemical treatment pumps and equipment.

J. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, and equipped with the following:
1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
2. Install water meter in makeup-water supply.
3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
5. Install a swing check on the inlet after the isolation valve.

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3.5 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance.

B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232116 "Hydronic Piping Specialties."

C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

D. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

E. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
   2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
   3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
   4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
   5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
   7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

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8. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. Equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. At four-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising RSCCD Representative of changes necessary to adhere to "Performance Requirements" Article.

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F. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
2. Acidity and Alkalinity: ASTM D 1067.
3. Iron: ASTM D 1068.
4. Water Hardness: ASTM D 1126.

3.7 WATER TREATMENT SEQUENCE

A. Pre-Treatment and Flush
1. This step should be done within 24 hour of the disinfection procedure.
2. Isolate existing piping from new piping so as to circulate solution in the newly installed pipe system ONLY.
3. Contractor shall provide valves and piping as necessary to bypass the existing water systems.
4. Add sufficient neutral-based cleaner, as recommended by the manufacturer, to the system and/or coils water, and circulate for 24-36 hours at full flow.
5. Drain and refill and flush the system with city water for at least one (1) hour or until the rinse water is clean of any particulates or oil. Continue the flushing procedure until the water is equivalent to city water.
6. At the end of the cleaning, take and analyze water samples as noted in the notes section above.

B. Passivation
1. Start passivation at the end of the cleaning cycle, no longer than six (6) hours later.
2. Add the passivation chemical to the system and circulate for six (6) hours, but test after two (2) hours for nitrate or molybdate and azole levels to ensure the required levels are reached, as shown in the notes section above. If the levels are below the required levels, then add additional chemicals and retest in another two (2) hours. Repeat until the proper levels are reached. Once the proper levels are reached, circulate for six (6) hours.
3. At the end of passivation, take and test water samples for the nitrate or molybdate and azole levels.
4. Once approved, the new system and/or coils may be tied into the campus TES chilled water and/or heating hot water system.

C. Inhibitor
1. Start inhibitors at the end of the cleaning cycle, no longer than six (6) hours later.
2. Add the inhibitors chemical to the system and circulate for six (6) hours, but test after two (2) hours inhibitor levels. If the levels are below the required levels, then add

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additional chemicals and retest in another two (2) hours. Repeat until the proper levels are reached.

3. After adding inhibitor, take and test water samples for the nitrate or molybdate and azole levels.

D. Once approved, the new system and/or coils may be tied into the campus chilled water and/or heating hot water system.

3.8 RECORDS MANAGEMENT:

A. A copy of this procedure shall be kept in the Procedures Manual maintained by the FM Director's Assistant.

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3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

B. Provide 8hrs of training for the owner's maintenance personnel and video record the training. Provide three DVC copies of the training to the owner's representative.

C. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

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SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Single-wall round ducts and fittings.
4. Double-wall round ducts and fittings.
5. Sheet metal materials.
6. Duct liner.
7. Sealant and gaskets.
8. Hangers and supports.
9. Seismic-restraint devices.

B. Related Sections:
1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.
   3. Seismic-restraint devices.

B. LEED Submittals:
   1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
   2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
   3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."
   4. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-up."
   5. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
   6. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
   4. Elevation of top of ducts.
   5. Dimensions of main duct runs from building grid lines.
   6. Fittings.
   7. Reinforcement and spacing.
   8. Seam and joint construction.
   9. Penetrations through fire-rated and other partitions.
   10. Equipment installation based on equipment being used on Project.
   11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
   12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

D. Delegated-Design Submittal:
   1. Sheet metal thicknesses.
   2. Joint and seam construction and sealing.
   3. Reinforcement details and spacing.
   4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
   2. Suspended ceiling components.
   3. Structural members to which duct will be attached.
   4. Size and location of initial access modules for acoustical tile.
   5. Penetrations of smoke barriers and fire-rated construction.
   6. Items penetrating finished ceiling including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
      f. Perimeter moldings.

B. Welding certificates.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
   3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-

support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. All exterior supply and return ductwork shall be provided with 2" internal duct insulation liner.

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. United Sheet Metal Division, United McGill
2. Semco Manufacturing, Inc.
3. Or equal

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

G. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.

H. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Traverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. Factory- or shop-fabricated spiral lock seam duct:
   a. No snap lock
   b. Factory-fabricated longitudinal seam acceptable for ducts larger than standard factory sizes

   Manufacturers:
   c. United Sheet Metal Division, United McGill
   d. Semco Manufacturing, Inc.
   e. Or equal

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Fittings:
1. Same material and construction as duct in which installed

2. For ductwork exposed to occupant view, do not use fabricated fittings at taps to terminal units and outlets. Instead use saddle tap cut into continuous spiral duct. Intent is for spiral duct to be continuous for aesthetic reasons. Saddle tap flange width shall be 0.5 inches or less.

F. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 DOUBLE-WALL ROUND DUCTS AND FITTINGS

A. Manufacturers:
1. United Sheet Metal Division, United McGill
2. Semco Manufacturing, Inc.
3. Or equal

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent.

E. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2.5 KITCHEN GREASE HOOD EXHAUST DUCT

A. Provide Type 1 grease exhaust duct. The grease exhaust duct shall comply comply with NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

B. The grease duct shall be provided and installed in accordance with section 510 of the California Mechanical Code.

C. Grease Duct Enclosure
1. Grease duct shall be enclosed with by a fire resistive horizontal and vertical shaft with a 1-hour fire resistive rating.
2. A minimum of 6" clearance shall be provided between the grease exhaust duct and enclosure.

D. Factory Built Grease Duct
1. The contractor shall have the option to provide Factory Built grease ducts if they are installed in accordance with the manufacturer's listing and installation instruction.
2. All supports for a Factory Built grease duct system shall be fire protected with the same rating as the Factory Built grease duct.

E. Duct Installation
1. Slope
   a. Ducts shall be installed with not less than 2 percent slope on horizontal runs up to 75 feet and not less than 8 percent slope on horizontal runs more than 75 feet.
2. Accessibility.
   a. Openings required for accessibility shall be in accordance with Section 510.3.2 of the California Mechanical Code.

F. Single Wall Duct Construction
1. Concealed Grease Ducts: Grease ducts shall be constructed of black steel complying with ASTM A 527, minimum 16 ga., constructed in accordance with SMACNA's HVAC Duct Construction Standards.
2. Include all components to comply with NFPA 96, including cleanouts, transitions, adapters, and drain fitting. Weld all joints to provide liquid-tight seal.

G. Clean-out Access Panels
1. Provide every 10 feet and change of direction.
2. UL 1978 Listed and Meets NFPA 96 Standards.
3. Grease and air tight.
4. Manufacturer
   a. Ductmate Ultimate Door or approved equal.
5. Panels
   a. The ULtimate Access Door consists of two layers of 11 gauge steel.
6. Gasket
   a. High temperature ceramic board, rated to 2300°. Completely covers the surface of the outer plate
7. Fasteners

a. Two threaded fasteners are welded to the inner door and one fastener in each corner.

8. Template
   a. Self adhesive template provided for the exact size of duct opening required.
9. Provide with UL Door Installation Hardware
   a. Four 8" extension studs, washers, fasteners and "Do Not Obstruct" Sticker.

H. Grease Duct Ventilated Roof Curb
1. Provide a ventilated roof curb at the point the grease exhaust shaft and duct penetrate through the roof.
2. Manufacturer
   a. Greenheck Model GPFV or approved equal.
   b. Construction
      1) 18 Gauge galvanized sheet metal.
      2) Curb shall come fully formed on 3 sides and a single, fully welded seam.

2.6 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. General Applications (except as noted below): G60 Galvanized Coating.
2. Plenum Walls and Blank-Offs Where in Contact with Cooling Coil: G90 Galvanized Coating.
3. Exterior Applications: G90 Galvanized Coating.
4. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. 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.

2.7 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Owens-Corning Fiberglass all-service faced duct wrap.
   b. Or equal by Certainteed.
   c. Knauf.
   d. Manville.
   e. Or equal.

B. Insulation: ASTM C553; flexible, noncombustible blanket.
   a. 'K' ('Ksi') value : ASTM C518-70, 0.26 at 75∞F.
   b. Maximum service temperature: 250∞F.
   c. Density: 3.0 lb/cu ft.
   d. Maximum Velocity on Coated Air Side: 4,000 ft/min.

C. Liner Fasteners: Galvanized steel with press-on head conforming to SMACNA.

D. Adhesive:
   1. Manufacturers: Owens-Corning or equal (no known equal).
   2. Waterproof fire-retardant type conforming to ASC-A-7001C.

E. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

F. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps, and coat joint with adhesive.
   4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
   5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
   6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
   7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
   8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
      a. Fan discharges.
      b. Intervals of lined duct preceding unlined duct.

c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
   a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.8 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   3. Shore A Hardness: Minimum 20.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.
   1. General: Single-component, acid-curing, silicone, elastomeric.
   2. Type: S.
   3. Grade: NS.
   4. Class: 25.
   5. Use: O.
   6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.9 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.10 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Hilti Corp.
2. TOLCO; a brand of NIBCO Inc.
3. Unistrut Corporation; Tyco International, Ltd.
4. Or equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by the Office of Statewide Health Planning and Development for the State of California.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round[and flat-oval] ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
   1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   2. Outdoor, Supply-Air Ducts: Seal Class A.
   3. Outdoor, Exhaust Ducts: Seal Class B.
   4. Outdoor, Return-Air Ducts: Seal Class A.
   5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 1-Inch wg and Lower: Seal Class B.
   6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 1-Inch wg: Seal Class A.
   7. Unconditioned Space, Exhaust Ducts: Seal Class B.
   8. Unconditioned Space, Return-Air Ducts: Seal Class A.
   9. Conditioned Space, Supply-Air Ducts in Pressure Classes 1-Inch wg and Lower: Seal Class B.
   10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 1-Inch wg: Seal Class A.
   11. Conditioned Space, Exhaust Ducts: Seal Class A.
   12. Conditioned Space, Return-Air Ducts: Seal Class A.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an evaluation service member of the ICC Evaluation Service.

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

G. Drilling for and Setting Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect 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 applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
   a. Medium Pressure Ducts with a Pressure Class of 1.9-Inch W.G. or higher: Supply air ducts from the air handler to the VAV boxes.
   b. Grease Exhaust Duct: From grease hood point of connection to the exhaust fan point of connection.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days advance notice for testing.

C. Duct System Cleanliness Tests:
1. Visually inspect duct system to ensure that no visible contaminants are present.

D. Contractor shall develop and implement an IAQ Management Plan for the construction and preoccupancy phases of the building as follows:
   1. During construction meet or exceed the recommended control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings Under Construction, and Edition 2007, ANSI/SMACNA 008-2008 (Chapter 3).
   2. Protect stored materials on-site and installed absorptive materials from moisture damage.
   3. If permanently installed air handlers are used during construction, then filtration media with a minimum efficiency reporting value (MERV) of 8 must be used at each return air grille, as determined by ASHRAE Standard 52.2-2012 (with errata, but without addenda). Replace air filtration media immediately prior to occupancy.

E. Duct system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.9 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated. Pressure class and leakage rate shall be as follows:

B. Supply Ducts:
   1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
      a. Pressure Class: Positive 1-inch wg.
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 8.
      d. SMACNA Leakage Class for Round and Flat Oval: 4.
   2. Ducts Connected to Variable-Air-Volume Air-Handling Units:
      a. Pressure Class: Positive 3-inch wg.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 4.
      d. SMACNA Leakage Class for Round and Flat Oval: 2.

C. Return Ducts:
   1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
      a. Pressure Class: Positive or negative 1-inch wg.
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 8.
      d. SMACNA Leakage Class for Round and Flat Oval: 4.
   2. Ducts Connected to Air-Handling Units:
      a. Pressure Class: Positive or negative 3-inch wg.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 4.
      d. SMACNA Leakage Class for Round and Flat Oval: 2.

D. Exhaust Ducts:
   1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
      a. Pressure Class: Negative 2-inch wg.
      b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
      c. SMACNA Leakage Class for Rectangular: 4.
      d. SMACNA Leakage Class for Round and Flat Oval: 2.
   2. Grease Exhaust Ducts Connected to Grease Fans Exhausting kitchen Type 1 (Grease) hoods
      a. Pressure Class: Negative 3-inch wg.
      b. Duct shall be welded with no more than 1% leakage at 1.5 times the Pressure Class.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
   1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
      a. Pressure Class: Positive or negative 2-inch wg.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 4.
      d. SMACNA Leakage Class for Round and Flat Oval: 2.
   2. Ducts Connected to Air-Handling Units:
      a. Pressure Class: Positive or negative 2-inch wg.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 4.
      d. SMACNA Leakage Class for Round and Flat Oval: 2.

F. Intermediate Reinforcement:
   1. Galvanized-Steel Ducts: Galvanized steel.
   2. PVC-Coated Ducts:
      a. Exposed to Airstream: Match duct material.
      b. Not Exposed to Airstream: Match duct material.
   3. Stainless-Steel Ducts:
      a. Exposed to Airstream: Match duct material.
      b. Not Exposed to Airstream: Match duct material.
   4. Aluminum Ducts: Aluminum.

G. Liner:
   1. Supply Air Ducts: Fiberglass, 2 inches thick.
   2. Return Air Ducts: Fiberglass, 2 inches thick.
   3. Transfer Ducts: Not required.

H. Double-Wall Duct Interstitial Insulation:
   1. Supply Air Ducts: 2 inches thick.
   2. Return Air Ducts: 2 inches thick.
   3. Exhaust Air Ducts: 2 inches thick.

I. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
      a. Velocity 1000 fpm or Lower:
         1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
         2) Mitered Type RE 4 with single-thickness turning vanes.
      b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and single-thickness turning vanes.
3) Mitered Type RE 2 with single-thickness vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:
1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.5 radius-to-diameter ratio and single-thickness turning vanes.
3) Mitered Type RE 2 with single-thickness vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and single-thickness turning vanes.
c. Mitered Type RE 2 with single-thickness vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
1) Velocity 1000 fpm or Lower: 1.0 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.5 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.
b. Round Elbows, 10 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 12 Inches and Larger in Diameter: Welded.

J. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.
2. Taps shall be the more stringent of what is shown on the mechanical drawings and the criteria listed below. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
a. Velocity 900 fpm or Lower: 90-degree tap.
b. Velocity 901 to 1500 fpm : Conical tap.
c. Velocity 1501 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

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SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Combination fire and smoke dampers.
7. Flange connectors.
8. Duct silencers.
9. Remote damper operators.
10. Duct-mounted access doors.
11. Flexible connectors.
12. Duct accessory hardware.

B. Related Requirements:
1. Section 233346 "Flexible Ducts" for insulated and non-insulated flexible ducts.
2. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

e. Duct security bars.
f. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
2. Pottorff.
3. Ruskin Company.
4. Or equal.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: Hat-shaped, 0.05-inch-thick, galvanized sheet steel, with welded corners or mechanically attached.

F. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.

G. Blade Action: Parallel.

H. Blade Axles:
1. Material: Nonferrous metal.
2. Diameter: 0.20 inch.

I. Tie Bars and Brackets: Galvanized steel.

J. Return Spring: Adjustable tension.

K. Bearings: Steel ball or synthetic pivot bushings.

L. Accessories:
1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.
   a. Sleeve Thickness: 20 gage minimum.
   b. Sleeve Length: 6 inches minimum.
6. Screen Mounting: Rear mounted.

7. Screen Material: Galvanized steel.
8. Screen Type: Bird.
9. 90-degree stops.

2.4 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck Fan Corporation.
   2. Pottorff.
   3. Ruskin Company.
   4. Or equal.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 1000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: Hat-shaped, 0.05-inch-thick, galvanized sheet steel, with welded corners or mechanically attached.

F. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.

G. Blade Axles: Nonferrous metal.

H. Tie Bars and Brackets:
   1. Material: Galvanized steel.
   2. Rattle free with 90-degree stop.

I. Return Spring: Adjustable tension.

J. Bearings: Synthetic.

K. Accessories:
   1. Flange on intake.
   2. Adjustment device to permit setting for varying differential static pressures.

2.5 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Aire Technologies.
      b. Pottorff.
      c. Ruskin Company.
      d. Or equal.

2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized-steel, 0.064 inch thick.
6. Blade Axles: Nonferrous metal.
7. Bearings:
   a. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

2.6 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating; a Mestek Architectural Group company.
   2. Greenheck Fan Corporation.
   3. Pottorff.
   4. Or equal.

B. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:
   1. 0.094-inch-thick, galvanized sheet steel.

D. Blades:
   1. Multiple blade with maximum blade width of 8 inches.
   2. Parallel-blade design.
   3. Galvanized-steel.
   4. 0.064 inch thick single skin.
   5. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch-diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
   1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:
   1. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   2. Thrust bearings at each end of every blade.

2.7 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff.
   2. Greenheck Fan Corporation.
   3. Ruskin Company.
   4. Or equal.

B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.05 or 0.39 inch thick, as indicated, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.024-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.8 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff.
   2. Greenheck Fan Corporation.
   3. Ruskin Company.
   4. Or equal.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000 fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Heat-Responsive Device: Resettable, 165 deg F rated, fire-closure device.

F. Smoke Detector: Integral, factory wired for single-point connection.

G. Blades: Roll-formed, horizontal, interlocking, 0.063-inch- thick, galvanized sheet steel.

H. Leakage: Class I.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, 0.039-inch- thick, galvanized sheet steel; length to suit wall or floor application.

K. Master control panel for use in dynamic smoke-management systems.

L. Damper Motors: two-position action.

M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
   3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
   5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
   6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
   7. Electrical Connection: 115 V, single phase, 60 Hz.

N. Accessories:
   1. Auxiliary switches for signaling position indication .
   2. Momentary test switch, mounted.

2.9 FLANGE CONNECTORS

A. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gage and Shape: Match connecting ductwork.

2.10 DUCT SILENCERS

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

1. Vibro Acoustics
2. Ruskin Company.
3. Industrial Noise Control, Inc.
4. Or equal.

B. General Requirements:
1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Shape:
1. Rectangular straight with splitters or baffles.
2. Round straight with center bodies or pods.
3. Rectangular elbow with splitters or baffles.
4. Round elbow with center bodies or pods.
5. Rectangular transitional with splitters or baffles.

D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel, 0.034 inch thick.

E. Round Silencer Outer Casing: ASTM A 653/A 653M, G60, galvanized sheet steel.
1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 0.034 inch thick.
2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 0.040 inch thick.
3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 0.05 inch thick.
4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 0.064 inch thick.

F. Inner Casing and Baffles: ASTM A 653/A 653M, G90 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch-diameter perforations.

G. Special Construction:
1. Suitable for outdoor use.

H. Connection Sizes: Match connecting ductwork unless otherwise indicated.

I. Principal Sound-Absorbing Mechanism:
1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
2. Film-lined type with fill material.
   a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression.
   b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.

J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
   1. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
   2. Reinforcement: Cross or trapeze angles for rigid suspension.

K. Accessories:
   1. Factory-installed end caps to prevent contamination during shipping.
   2. Removable splitters.
   3. Airflow measuring devices.

L. Source Quality Control: Test according to ASTM E 477.
   1. Testing of mockups to be witnessed by Owner.
   2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
   3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

M. Capacities and Characteristics:
   1. Configuration: Straight.
   2. Shape: Rectangular.
   3. Attenuation Mechanism: Acoustical glass fiber with protective film liner.
   4. Casing:
      a. Attenuation: Standard.
      b. Outer Material: Galvanized steel.
      c. Inner Material: Galvanized steel.

2.11 REMOTE DAMPER OPERATORS

A. Description: Cable system designed for remote manual damper adjustment.

B. Tubing: Brass.

C. Cable: Stainless steel.

D. Wall-Box Mounting: Recessed.

2.12 DUCT-MOUNTED ACCESS DOORS

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

   1. Aire Technologies.
   2. Greenheck Fan Corporation.
   3. Pottorff.
   4. Or equal.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Vision panel.
      d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
      e. Fabricate doors airtight and suitable for duct pressure class.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Number of Hinges and Locks:
      a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
      b. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
      c. Access Doors Larger Than 24 by 48 Inches: and two compression latches with outside and inside handles.

2.13 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   1. Minimum Weight: 26 oz./sq. yd..
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd..
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.

F. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
   1. Minimum Weight: 16 oz./sq. yd..
   2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F.

G. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
   1. Minimum Weight: 14 oz./sq. yd..
   2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F.

H. Thrust Limits: 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 fan discharge and duct.
   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. Outdoor 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 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 1/4-inch movement at start and stop.

2.14 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire and smoke dampers according to UL listing.

G. Install duct security bars. Construct duct security bars from 0.164-inchsteel sleeve, continuously welded at all joints and 1/2-inch-diameter steel bars, 6 inches o.c. in each direction in center of

sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch steel angle to 4 sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.

H. Connect ducts to duct silencers rigidly.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. At each change in direction and at maximum 50-foot spacing
   8. Upstream or downstream from duct silencers.
   9. Control devices requiring inspection.
   10. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.
   3. Head and Hand Access: 18 by 10 inches.
   4. Head and Shoulders Access: 21 by 14 inches.
   5. Body Access: 25 by 14 inches.
   6. Body plus Ladder Access: 25 by 17 inches.

L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Install duct test holes where required for testing and balancing purposes.

P. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.
   5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

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SECTION 233346 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Non-insulated flexible ducts.
   2. Insulated flexible ducts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For flexible ducts.
   1. Include plans showing locations and mounting and attachment details.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."

D. Comply with ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 NON-INSULATED FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flexmaster U.S.A., Inc.
   2. McGill AirFlow LLC.
   3. Thermaflex; a Flex-Tek Group company.
   4. Or equal.

B. Non-Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 10 to plus 160 deg F.

C. Non-Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.
   1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 20 to plus 175 deg F.

D. Non-Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 20 to plus 210 deg F.

E. Non-Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 20 to plus 210 deg F.

F. Non-Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil.
   1. Pressure Rating: 8-inch wg positive or negative.
   2. Maximum Air Velocity: 5000 fpm.
   3. Temperature Range: Minus 100 to plus 435 deg F.

2.3 INSULATED FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flexmaster U.S.A., Inc.
   2. McGill AirFlow LLC.
   3. Thermaflex; a Flex-Tek Group company.
   4. Or equal.

B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
   1. Pressure Rating: 6-inch wg positive and 1.0-inch wg negative.

2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: R6.

2.4 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

B. Non-Clamp Connectors: Adhesive plus sheet metal screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.

C. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

D. Install duct test holes where required for testing and balancing purposes.

E. Installation:
1. Install ducts fully extended.
2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns.

F. Supporting Flexible Ducts:
1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION 233346

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SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

Specifier Note: Add additional types of fans as required by project requirements.

A. Section Includes:
   1. Utility set fans.
   2. Centrifugal roof ventilators.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.
   8. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC fans to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Belts: One set(s) for each belt-driven unit.

1.7 QUALITY ASSURANCE

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

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: HVAC fans shall comply with UL 705. HVAC fans for use for restaurant kitchen exhaust shall also comply with UL 762.

1.8 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

D. Provide access around equipment as specified on plans and/or according to manufacturer's requirements.

1.9 WARRANTY

A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents

B. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturers option when returned to Manufacturer, transportation prepaid.

PART 2 - PRODUCTS

2.1 BELT DRIVE ROOF UPBLAST GREASE STEEL GREASE CENTRIFUGAL EXHAUST FAN

A. Manufacturers:
1. Greenheck Model USF
2. Or equal by Loren Cook
3. PennBarry
4. Twin City Fans

B. General
1. Base fan performance at standard conditions (density 0.075 Lb/ft3).
2. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
3. Each fan shall be belt in AMCA arrangement 10 according to drawings.
4. Fans are to be equipped with lifting lugs.
5. After fabrication, all carbon steel components shall be cleaned and chemically treated by a phosphatizing process to insure proper removal of grease, oil, scale, etc. Fan shall then be coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be RAL-7023, concrete grey. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.

C. Fan Housing and Outlet
1. Fan housing is to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
2. Fan shall be of airtight PermaLockTM construction with the scroll panel material formed and embedded into the side panels continuously welded heavy gauge scroll construction. All interior and exterior surface steel shall be coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be RAL-7023, concrete grey. No uncoated metal fan parts will be allowed.
3. Housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings.
4. An OSHA compliant belt guard shall be included to completely cover the motor pulley and belt(s).

D. Fan Wheel
1. The fan wheel shall be of the non-overloading single width backward inclined centrifugal type. Wheels shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19.
2. Fan wheel shall be manufactured of single thickness blades securely riveted to a heavy gauge back plate and wheel cone.
3. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

E. Fan Motor and Drive
1. Motors shall meet or exceed EISA (Energy Independence and Security Act) efficiencies. Motors to be NEMA T-frame, 1800 or 3600 RPM, Open Drip Proof Totally Enclosed Fan Cooled (TEFC), with a 1.15 service factor.
2. Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required.
3. Fan shaft to be turned and polished 316 stainless steel that is sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class.
4. Fan shaft bearings shall be Air Handling Quality, bearings shall be heavy-duty grease lubricated, self-aligning or roller pillow block type.
5. Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to insure the inner race diameter is within tolerance to prevent vibration.
6. Bearings shall be selected for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each pressure class {Average Life or (L-50) of 400,000 hours}.

7. Bearings shall have Zerk fittings to allow for lubrication

2.2 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers:
1. Greenheck G-VG
2. Or Equal by Loren Cook
3. PennBarry
4. Twin City Fans

B. General Description:
1. Downblast fan shall be for roof mounted applications
2. Fans are available in sixteen sizes with nominal wheel diameters ranging from 8 inches through 18 inches (071 - 180 unit sizes)
3. Maximum continuous operating temperature is 180 Fahrenheit
4. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.

C. Wheel:
1. Constructed of aluminum
2. Non-overloading, backward inclined centrifugal
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

D. Motors:
1. Electronically Commutated Motor
   a. Motor enclosures: Open type
   b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
   c. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
   d. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
   e. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
   f. Motor shall be a minimum of 85% efficient at all speeds.

E. Housing:
1. Motor cover, shroud, curb cap, and lower windband shall be constructed of heavy gauge aluminum
2. Shroud shall have an integral rolled bead for extra strength
3. Shroud shall be drawn from a disc and direct air downward
4. Lower windband shall have a formed edge for added strength
5. Motor cover shall be drawn from a disc
6. All housing components shall have final thicknesses equal to or greater then preformed thickness.

7. Curb cap shall have pre-punched mounting holes to ensure correct attachment
8. Rigid internal support structure
9. Leak proof

F. Housing Supports and Drive Frame:
1. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators

G. Vibration Isolation:
1. Rubber isolators
2. Sized to match the weight of each fan

H. Disconnect Switches:
1. NEMA rated: 3R
2. Positive electrical shut-off
3. Wired from fan motor to junction box installed within motor compartment

I. Options/Accessories:
1. Birdscreen:
   a. Material Type: Galvanized
   b. Protects fan discharge
2. Roof Curbs:
   a. Types: GPS
   b. Mounted onto roof with fan
   c. Material: Galvanized
   d. Insulation thickness: None
   e. Coating Type: Permatector
3. Curb Seal:
   a. Rubber seal between the fan and the roof curb
4. Dampers:
   a. Type: Gravity
   b. Prevents outside air from entering back into the building when fan is off
   c. Balanced for minimal resistance to flow
   d. Galvanized frames with prepunched mounting holes

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install HVAC fans level and plumb.

B. Equipment Mounting:
   1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
   2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.

D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

F. Install units with clearances for service and maintenance of fans, motors and all other components that may need access

G. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to HVAC fans to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 233423

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SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Shutoff, single-duct air terminal units.
   2. Casing liner.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:
   1. Product Data: For adhesives, indicating VOC content.
   2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For air terminal units.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
   4. Hangers and supports, including methods for duct and building attachment and vibration isolation.

D. Delegated-Design Submittal:
   1. Materials, fabrication, assembly, and spacing of hangers and supports.
   2. Include design calculations for selecting hangers and supports.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
a. Instructions for resetting minimum and maximum air volumes.
b. Instructions for adjusting software set points.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Krueger.
2. Price Industries.
3. Titus.
4. Or equal.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.034-inch- thick galvanized steel, single wall.
1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.

4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
2. Damper Position: Normally open.

F. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

G. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
1. Electronic Damper Actuator: 24 V, powered open.
2. Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
   a. Occupied and unoccupied operating mode.
   b. Remote reset of airflow or temperature set points.
   c. Adjusting and monitoring with portable terminal.
   d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
3. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

H. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

I. Control Sequences: See VAV Reheat Terminal Unit as specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

2.3 CASING LINER

A. Casing Liner: Flexible elastomeric duct liner fabricated of preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
1. Minimum Thickness: 1.0" inch.
2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
   a. Adhesive shall have a VOC content of 80 g/L or less.
   b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of

Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to AHRI 880.
   1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.2 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." Comply with requirements for seismic-restraint devices in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on air terminal units that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

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

G. Drilling for and Setting Anchors:
   1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect 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. Install heavy-duty sleeve anchors 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 applications and stainless-steel anchors for applications exposed to weather.

3.3 TERMINAL UNIT INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.4 CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

B. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.

D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.5 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.6 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
   2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
   3. Verify that controls and control enclosure are accessible.
   4. Verify that control connections are complete.
   5. Verify that nameplate and identification tag are visible.
   6. Verify that controls respond to inputs as specified.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

SECTION 233713 – DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Round ceiling diffusers.
2. Architectural plaque diffusers.
3. Perforated diffusers.
4. Louver face diffusers.
5. Linear bar diffusers.
6. Linear slot diffusers.
7. High-capacity drum louver diffusers.
8. Modular-core supply grille diffusers.
9. Adjustable blade face grilles.
10. Fixed face grilles.
11. Linear bar grilles.

1.3 ACTION SUBMITTALS

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
1. "No Exception Taken".
2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of product.
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 and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.

3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 GENERAL

A. The first manufacturer listed is the Basis of Design for the project as indicated on the plans.

2.2 SQUARE CEILING DIFFUSERS

A. Manufacturers:
1. Titus TMS.
2. Krueger.
3. Price Industries.
4. Or equal

B. Square ceiling diffusers shall be aluminum with steel support bar and shall have three cones, to give uniform face size and appearance when different neck sizes are used in the same area.

C. All cones shall be one piece precision die-stamped; the back cone shall also include an integrally drawn inlet (welded-in inlets and corner joints are not acceptable). The two inner cones shall be constructed as a single, removable inner cone assembly for easy installation and cleaning. The inner cone assembly must have a hole with removable plug in the center to allow quick adjustment of an optional inlet damper without removing the inner cone assembly. Diffusers shall be constructed of 0.040 aluminum.

D. The finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes.

E. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

F. The manufacturer shall provide published performance data for the square diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

2.3 ROUND CEILING DIFFUSERS

A. Manufacturers:
1. Titus TMRA.
2. Krueger.
3. Price Industries.

4. Or equal

B. Devices shall be specifically designed for variable-air-volume flows.

Face Style: Round Ceiling Diffusers shall have four cones and round neck inlets of the sizes and mounting types shown on the plans and outlet schedule. Round diffusers shall be constructed of 18-gauge steel.

C. Airflow Pattern: Fully adjustable - airflow discharge pattern shall be field adjustable from horizontal to vertical by extending or retracting the inner three cones. These three cones shall be constructed as a single inner assembly and must be easily removable using a spring lock mechanism. Vertical to horizontal discharge pattern must be achieved by one of three adjustment methods as follows:
1. Type 1. The inner cone assembly can be removed and repositioned by means of adjusting screws.
2. Type 2. The inner cone assembly can be adjusted by sliding the cones up or down.
3. Type 3. The center cone can be rotated clockwise or counterclockwise to move the cones up or down.

D. Material: Steel.

E. Mounting: Duct connection.

F. Finish: The finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

G. The manufacturer shall provide published performance data for the round diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

2.4 PERFORATED RETURN AIR GRILLES DIFFUSERS

A. Manufacturers:
1. Titus PAR.
2. Krueger.
3. Price Industries.
4. Or equal.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: Steel backpan with 50% free area perforated steel face.

D. Finish: Baked enamel, white.

E. Face Size: 24 by 24 inches

F. Duct Inlet: Round.

G. Face Style: Flush.

H. Mounting: T-bar or gypsum board ceiling.

I. Pattern Controller: None.

J. Dampers: None.

K. Accessories:
1. Safety chain.

2.5 DIRECT SPIRAL DUCT-MOUNTED SUPPLY GRILLES

A. Grilles shall be direct spiral duct-mounted supply grilles model S300FL.

B. The deflection blades shall be parallel to the long dimension of the grille.

C. All supply grilles shall be constructed with radius end caps and foam gaskets for a tight seal to the duct diameter.

D. All supply grilles shall be constructed with a 1 3/8-inch wide border.

E. Material: Aluminum

F. Deflection Pattern: Double

G. Blades shall be constructed of heavy duty extruded aluminum and shall be spaced ¾-inch apart. Blades shall extend completely through the side frame on each side to ensure stability throughout the complete cfm operating range of the grille.

H. Blades shall be individually adjustable without loosening or rattling and shall be securely held in place with tension wire.

I. Finish: The finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

J. The manufacturer shall provide published performance data for the round diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

2.6 LINEAR SLOT DIFFUSERS

A. Manufacturers:
1. Titus ML Series.
2. Krueger.
3. Price Industries.
4. Or equal.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material - Shell: Aluminum, insulated.

D. Material - Pattern Controller and Tees: Aluminum.

E. Finish: **Custom Color selected by Architect.** The finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

F. Finish - Pattern Controller: **Baked enamel, black.**

G. Slot Width: See Diffuser schedule on Mechanical Plans.

H. Number of Slots: See Diffuser schedule on Mechanical Plans.

I. Length: See Diffuser schedule on Mechanical Plans.

J. The manufacturer shall provide published performance data for the round diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

K. Accessories: Center notch integrated into wood panel ceiling. To be coordinated by the mechanical contractor with the architect.

2.7 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 233723 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Louvered-penthouse ventilators.
   2. Roof hoods.
   3. Goosenecks.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design ventilators, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.

B. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
   1. Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft., acting inward or outward.

C. Seismic Performance: Ventilators, including attachments to other construction, 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.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
   1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

C. Samples: For each exposed product and for each color and texture specified.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of louvered-penthouse ventilator indicated, in manufacturer's standard size.

F. Delegated-Design Submittal: For shop-fabricated ventilators 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. Detail fabrication and assembly of shop-fabricated ventilators.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members to which roof curbs and ventilators will be attached.
   2. Sizes and locations of roof openings.

B. Seismic Qualification Certificates: For ventilators, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.7 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 MATERIALS

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

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

C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.

D. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 finish.

E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
1. Use types and sizes to suit unit installation conditions.
2. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.

F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

2.2 FABRICATION, GENERAL

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

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

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.3 SPUN ALUMINUM RELIEF GRAVITY ROOF VENTILATOR

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

1. BASIS of Design Greenheck Model GRSR
2. Or equal by Loren Cook Company
3. Twin City
4. Penn Bsrry

B. General Description:
   1. Ventilator is low silhouette for relief applications with natural gravity or negative pressure system
   2. Selection based on non-ducted applications
   3. Intake unit sizes 8 to 48
   4. Performance capability up to 18,200 cubic feet per minute (cfm)
   5. Each unit shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number

C. Hood:
   1. Constructed of aluminum
   2. Internal structure is constructed of galvanized steel

D. Birdscreen:
   1. Constructed of ½ inch[Galvanized] [Aluminum] mesh
   2. Mounted horizontally across the intake area of the hood

E. Housing:
   1. Curb Cap type: Hinged.
   2. Constructed of aluminum, includes windband and curb cap. Galvanized material is not acceptable
   3. Windband to be one-piece spun aluminum construction and maintain original material thickness throughout the housing.
   4. Windband to include an integral rolled bead for strength
   5. Curb cap to have integral deep spun inlet venturi and prepunched mounting holes to ensure correct attachment to roof.

F. Options/Accessories:
   1. Curb Seal:
      a. Rubber seal between fan and the roof curb
   2. Roof Curbs:
      a. Type: GPS
      b. Mounted onto roof with fan
      c. Material: Galvanized
      d. Insulation thickness: None.
      e. Coating Type: Permatector.
   3. Dampers:
      a. Type: Barometric Relief-see equipment schedule.
      b. Prevents outside air from entering back into the building when fan is off
      c. Balanced for minimal resistance to flow
      d. Galvanized frames with prepunched mounting holes
   4. Finishes:
      a. Type: Galvanized steel.
   5. Flashing Flange:
      a. Constructed of aluminum
   6. Hood Insulation:
      a. Lined with 1 inch fiberglass insulation to prevent condensation and sound levels
   7. Insect Screen:
      a. Constructed of 1/4” x 1/4" aluminum wire mesh
      b. Fitted to the top of the throat and prevents entry of insects
   8. Tie-Down Points:

a. Four aluminum brackets located on windband secures fan in heavy wind applications

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Install goosenecks on curb base where throat size exceeds 8 by 8 inches.

C. Install gravity ventilators with clearances for service and maintenance.

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

E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 079200 "Joint Sealants" for sealants applied during installation.

F. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

G. 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.

H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore 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.

3.2 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION 233723

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SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes gas-fired, condensing boilers, trim, and accessories for generating hydronic heating boilers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
   2. Provide boiler control panel Sequence of Operation
   3. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For each boiler.
   1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
      a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
      b. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For boiler, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Wiring diagram

C. Installation and operating instructions

D. Source quality-control reports.

E. Field quality-control reports.

F. S.C.A.Q.M.D. Rule 1146.2 (<20 PPM NOx emissions @ 3% O2)

G. CSA Certified – AB 1953 & VLA 193 Low Lead Compliant

H. Regulatory Requirements
1. ANSI Z21.13/CSA 4.9

I. Sample Warranty: For special warranty.

J. Other Informational Submittals:
1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period of two years.
1. Warranty Period for Water-Tube Condensing Boilers:
a. Heat Exchanger Damaged by Thermal Shock: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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 boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N.

E. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

F. CSA Compliance: Test boilers for compliance with CSA B51.

G. Mounting Base: For securing boiler to concrete base.
   1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when mounting base is anchored to building structure.

2.2 CONDENSING BOILERS

A. Manufacturers:
   1. Raypak Boilers
   2. Laars
   3. Lochinvar
   4. or Equal

B. General
   1. Description: Factory-fabricated, -assembled, and -tested, condensing stainless steel hydronic heating boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water-heating service only.
   2. The boiler(s) shall be CSA tested and certified with a minimum thermal efficiency of 94 percent at full fire.
   3. The boiler(s) shall be ASME inspected and stamped and National Board registered for 160 PSIG maximum allowable working pressure and 210°F maximum allowable temperature, complete with a Manufacturer's Data Report.
   4. The boiler(s) shall have a floor loading of 95 lbs./square foot or less.

C. Primary Heat Exchanger
   1. The primary heat exchanger shall be of a helically wound, multi-pass design and shall completely encircle the combustion chamber for maximum efficiency.
   2. There shall be no banding material, gaskets or "O" rings in the header configuration. The heat exchanger is removable from the cabinet for replacement without removing the entire boiler assembly from the site. The stainless-steel combustion chamber shall be designed to have a trough located on the bottom front and back section leading to the middle to ensure that condensation does not collect in the boiler.
   3. The low water volume primary heat exchanger shall be explosion-proof on the water side and shall carry a twenty-five-year warranty against thermal shock.
   4. The flue connection, combustion air opening, gas connection, electrical connections and condensate drain shall be located on the rear. Water connections shall be located on the left rear top of the unit.

D. Condensate Drain
   1. The boiler(s) will feature a condensate float switch which will shut down the boiler(s) if the condensate drain is blocked.

E. Burner
   1. The combustion chamber shall be of the sealed combustion type employing the Raypak high temperature metal fiber burner, mounted in a horizontal orientation.
   2. The burner shall be a premix design and constructed of high grade Inconel and must be capable of firing at both a complete blue flame with maximum gas and air input as well as firing infrared when gas and air are reduced. The burner must be capable of firing at 100% of rated input when supplied with 4.0" WC of inlet gas pressure, so as to maintain service under heavy demand conditions; no exceptions.
   3. The burner shall use a combustion air blower to precisely control the fuel/air mixture for maximum efficiency throughout the entire range of modulation. The combustion air blower shall operate for a pre-purge period before burner ignition and a post-purge period after burner operation to clear the combustion chamber.
   4. The blower shall infinitely vary its output in response to a PWM signal supplied directly from the Versa IC modulating control, thereby electronically and precisely adjusting the volume of air and gas supplied for combustion. Minimum fire shall be 20 percent of rated input.

F. Ignition System
   1. The boiler(s) shall be equipped with a 100 percent safety shutdown.
   2. The ignition shall be spark ignition type with full flame rectification by the ignition source, with a four try-for-ignition sequence, to ensure consistent operation.
   3. The igniter will be located above the burner to ensure easy ignition.
   4. The Versa IC control module shall include an LCD display that indicates individual diagnostic faults.
   5. A viewing port shall be provided, permitting visual observation of burner operation.

G. Gas Train
   1. The boiler(s) shall have a firing/leak test valve and pressure test valve as required by CSD-1.
   2. The boiler(s) shall have dual-seated main gas valve.
   3. Gas control trains shall have a redundant safety shut-off feature, main gas regulation, and plugged pressure tapping to meet the requirements of ANSI Z21.13/CSA 4.9.

H. Boiler Control
   1. The following safety controls shall be provided:
      a. 200#F High limit control with manual reset (maximum system setpoint 190#F)
      b. Flow switch, mounted and wired
      c. PSIG ASME pressure relief valve, piped by the installer to an approved drain (shipped loose)
      d. Temperature and pressure gauge (shipped loose)
   2. The boiler(s) shall be equipped with an integrated PID modulating temperature controller with LCD display that incorporates an adjustable energy-saving pump control relay and freeze protection and is factory mounted and wired to improve system efficiency; three water sensors are included (system sensor is loose).
   3. The boiler(s) shall allow for 0-10 VDC input connection for remote building DDC system control of system temperature or firing rate and have a built-in "Cascade"

function to sequence and rotate while maintaining modulation of up to four boilers without utilizing an external sequencer.

I. Firing Mode: Provide electronic modulating control of the gas input to the boiler.

J. Boiler Diagnostics
1. Provide monitoring of all safeties, internal/external interlocks with fault display by a 3-1/2" LCD display:
   a. System status
   b. Ignition failure
   c. Condensate blockage
   d. Blower speed error
   e. Low 24VAC
   f. Manual reset high limit
   g. Auto reset high limit
   h. Low Water Cut Off (LWCO) (optional)
   i. Blocked vent
   j. Low gas pressure switch (optional)
   k. High gas pressure switch (optional)
   l. Flow switch fault
   m. Sensor failure
      1) Inlet sensor (open or short)
      2) Outlet sensor (open or short)
      3) System sensor (open or short)
      4) Air sensor (optional) (open or short)
      5) DHW sensor (optional) (open or short)
   n. High vent temperature
   o. Internal control fault
   p. ID Card fault
   q. Cascade communication error

K. Cabinet
1. The corrosion-resistant galvanized-steel jackets shall be finished with a baked-on epoxy powder coat, which is suitable for outdoor installation, applied prior to assembly for complete coverage.
2. The boiler(s), if located on a combustible floor, shall not require a separate combustible floor base.
3. The boiler(s) shall connect both the combustion air and flue products through the back of the unit.
4. The heater shall have as standard an internal, combustion air filter rated to MERV 8 (>95% arrestance).

L. Boiler Pump – The boiler(s) shall be equipped with an optional factory-packaged pump system.

2.3 BOILER OPERATING CONTROLS

A. Refer to Section 230900 Building Management System (BMS) and Section 230993 Sequence of Operations for HVAC DDC.

B. Integration into the Building Automation System

1. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.
2. Interface: Boiler shall be provided with factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
3. Hardwired Points:
   a. Monitoring: On/off status, common trouble alarm and low-water-level alarm.
   b. Control: On/off operation, hot-water-supply temperature set-point adjustment.

C. The boiler control panel shall have the ability to receive a 0 to 10 VDC signal from the Central Energy Management and Direct Digital Control System (EMCS) to vary the setpoint or control firing rate.

D. The boiler control panel shall have an alarm contact for connection to the central EMCS system.

E. Each boiler shall be equipped with BACnet communications compatibility with up to 146 points of data available.

F. The boiler(s) shall feature the integrated Versa IC modulating digital controller with 3 user selectable modes, mounted and wired.
1. Mode 1 = Hydronic, without indirect domestic hot water.
2. Mode 2 = Hydronic, with indirect domestic hot water plumbed into system loop piping
3. Mode 3 = Hydronic, with indirect domestic hot water plumbed into boiler loop plumbing

G. System sensor and optional air temperature sensor shall be shipped loose for field installation by installing contractor. Inlet/Outlet sensors are factory-installed.

H. Versa IC control system shall be capable of controlling:
1. Boiler pumps.

I. Boiler operating controls shall include the following devices and features:
1. Control transformer.
2. All set points shall be adjust.
3. Operating Pressure Control: Factory wired and mounted to cycle burner.
4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 40 deg F outside-air temperature, set supply-water temperature at 180 deg F; at 70 deg F outside-air temperature, set supply-water temperature at 130 deg F.
   a. Include automatic lead-lag and alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

2.4 TRIM

A. Include devices sized to comply with ASME B31.1.

B. TruSeal combustion air inlet.

C. Low Water Cut-off.

D. Condensate Neutralization Kit.

E. Safety Relief Valve: ASME rated.

F. Pressure and Temperature Gage: Minimum 3-1/2-inch diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.

G. Boiler Air Vent: Automatic.

H. Drain Valve: Minimum NPS 3/4hose-end gate valve.

I. Circulation Pump: Non-overloading in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.5 CONTROLS

A. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
   1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
   2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
   3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
   4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

2.6 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
   1. House in NEMA 250, Type 1 enclosure.
   2. Wiring shall be numbered, and color coded to match wiring diagram.
   3. Install factory wiring outside of an enclosure in a metal raceway.
   4. Field power interface shall be to [circuit breaker.
   5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.

2.7 VENTING KITS

A. Gas Vent Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, rain cap, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.8 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
   1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.2 BOILER INSTALLATION

A. Equipment Mounting:
   1. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Comply with requirements for vibration isolation and seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
   3. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Controls for HVAC."

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."

E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tappings with shutoff valve and union or flange at each connection.

H. Install piping from safety relief valves to nearest floor drain.

I. Install piping from safety valves to drip-pan elbow and to nearest floor drain.

J. Boiler Venting:
   1. Install flue venting kit and combustion-air intake.
   2. Connect full size to boiler connections. Comply with requirements in Section 235123 "Gas Vents."

K. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

L. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 START-UP

A. Shall be performed by Raypak factory-trained personnel.

B. Test during operation and adjust if necessary:
   1. Safeties
   2. Operating controls
   3. Static and full load gas supply pressure

4. Gas manifold and blower suction pressure
5. Combustion analysis

C. Submit copy of start-up report to Architect and Engineer.

3.5 FIELD QUALITY CONTROL

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

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

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and [water temperature] [steam pressure].
   b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Boiler will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

G. Performance Tests:
1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
   a. Test for full capacity.
   b. Test for boiler efficiency at low fire 20, 60, 80, 100, 40 and 20] percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
7. Notify Architect and Engineer 48 hours minimum in advance of test dates.
8. Document test results in a report and submit to Architect.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.

3.7 TRAINING

A. Provide factory-authorized service representative to train maintenance personnel on procedures and schedules related to start-up, shut-down, troubleshooting, servicing, and preventive maintenance.

B. Schedule training at least seven days in advance.

END OF SECTION 235216

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SECTION 237416 – CUSTOM AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes central station air handling units.

1.3 ACTION SUBMITTALS

A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of this particular specification section.
   1. The manufacturer shall resubmit this specification section showing compliance with each respective paragraphs and specified items and features.
   2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
   3. Individual or partial submittals are not acceptable and will be returned without review.

B. Submittals:
   1. Manufacturer shall provide the following information with each shop drawing/product data submission:
      a. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.
      b. Each component of the unit shall be identified and mechanical specifications shall be provided for unit and accessories describing construction, components, and options.
      c. All performance data, including capacities and airside and waterside pressure drops, for components.
      d. Fan curves shall be provided for fans with the design operating points indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes.
      e. A filter schedule must be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, unit size, corresponding filter section location within the AHU, filter arrangement (e.g. angled/flat), filter depth, filter type (e.g. pleated media), MERV rating, and filter quantity and size.
      f. A schedule detailing necessary trap height shall be provided for each air handling unit. Schedule shall detail unit tag, unit size, appropriate trap schematic with recommended trap dimensions, and unit supplied base rail height. Contractor shall be responsible for additional trap height required for trapping and insulation beyond the unit supplied base rail height by adequate housekeeping pad.

g. An electrical MCA - MOP schedule shall be provided for each electrical circuit to which field-power must be supplied. Schedule to detail unit tag, circuit description, voltage/phase/hertz, Minimum Circuit Ampacity (MCA), and calculated Maximum Overcurrent Protection (MOP).
h. Variable frequency drive (VFD) and motor data.
i. Sound Test for the AHU is in accordance with AMCA Standard 300-96, Reverberant Room Method for sound testing of fans, and where relevant, AHRI Standard 260-01, Sound Ratings of Ducted Air Moving and Conditioning Equipment. Sound data submitted is just theoretical data.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

B. Certificates: For certification required in "Quality Assurance" Article.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each air handling unit, provide emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE AND REGULATORY REQUIREMENTS

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

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. Comply with NFPA 70.

D. Unit shall bear an ETL label, conforming to UL Standard 1995. Units shall be provided with listing agency label affixed to the unit. In the event the unit is not ETL approved, the contractor shall, at his/her expense, provide for a field inspection by an ETL representative to verify conformance.

E. Fans are AMCA certified for sound and performance in accordance with AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes and AMCA 300 – Test Code for Sound Rating Air Moving Devices.

F. AMCA 301 – Method of Publishing Sound Ratings for Air Moving Devices.

G. AMCA 500 – Test Methods for Louver, Dampers, and Shutters

H. Certify air handling coils in accordance with AHRI Standard 410. Units shall be provided with certification label affixed to the unit. If air handling coils are not certified in accordance with AHRI Standard 410, contractor shall be responsible for expenses associated with testing of coils after installation to verify performance of coil(s). Any costs incurred to adjust coils to meet scheduled capacities shall be the sole responsibility of the contractor.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Shipping splits shall be clearly defined on submittal drawings. Cost associated with non-conformance to shop drawings shall be the responsibility of the manufacturer. Each section shall have lifting lugs for field rigging, lifting and final placement of AHU section(s).

C. Deliver units to jobsite with fan motor(s), and other components completely assembled and mounted in units.

D. Unit shall be shipped in a shrink-wrap or stretch-wrap to protect unit from in-transit rain and debris per ASHRAE 62.1 recommendations.

E. Installing contractor shall be responsible for storing AHU in a clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.8 EXTRA STOCK

A. Manufacturer shall provide one spare set of filters.

1.9 WARRANTY

A. Manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of five years from unit start-up. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

B. Contractor shall provide a Labor Warranty that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Haakon - Basis of Design
2. United Metal Products.
3. Temtrol.
4. Energy Labs
5. Or approved equal

B. If the contractor substitutes another manufacturer different than the basis of design, the contractor shall be responsible for seismic structural anchorage calculations for the substituted unit and submitting to DSA for review and approval.

2.2 MANUFACTURED UNIT

A. Manufacturer shall provide outdoor, rooftop, integral base frame unit to support and raise all sections of the unit for proper trapping. Unit base frames not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel. Unit base height to be included in trap

2.3 UNIT BASE

A. Unit base shall be fabricated from ASTM A36 welded structural steel channel or tubular steel. Formed bases are not acceptable. Bases shall be sized as a function of air handling length as follows:

Channel Construction:

Unit Length	Minimum Channel Size	Weight/Foot
Up to 10 feet	4" x 1-5/8"	5.4 lbs/ft
11 to 20 feet	6" x 2"	8.2 lbs/ft
21 to 30 feet	8" x 2-1/4"	11.5 lbs/ft
31 to 40 feet	10" x 2-3/5"	15.3 lbs/ft
41 to 50 feet	12" x 3"	20.7 lbs/ft

Tubular Steel Construction:

Unit Length x Width	Minimum Tube Size
Up to 16 feet x 97" wide	4" x 2"
Up to 20 feet x 139" wide	5" x 2"
Up 25 feet x 181" Wide	6" x 2"
Up to 25 feet x 300" wide	8" x 2"

B. Frame members shall be sized to limit deflection to L/200, minimizing deflection during rigging and installation. Intermediate tubular steel or C-Channel cross members are fully welded and located at lifting points and as needed to support internal components such as coils, fans, etc. Removable or welded lifting lugs shall be added to the perimeter channel along the longest length of the unit.

C. Structural floor panels shall be 12-gauge checker plate. Flooring seams shall be continuously welded. Drive screw attachment and caulking are not acceptable. Floors that "oil can" are not acceptable

E. The entire floor and frame shall be insulated with 2" fiberglass insulation. Provide 22 gauge galvanized steel liner.

F. The manufacturer shall provide a 1.5" perimeter collar around the entire unit and around each floor opening to ensure the unit is internally watertight. The entire base shall act as an auxiliary drain pan and hold up to 1.5" of water.

G. The manufacturer shall provide auxiliary drains in fan sections downstream of cooling coils and in mixing sections.

2.4 UNIT CASING

A. Housing: The unit housing side and roof panels shall be constructed of 16-gauge galvanized steel, 2" thick acoustic thermal panels. All permanently joined flanged panel surfaces shall be sealed with an individual strip of 1/8" x 3/8" tape sealer. Wall [and roof] seams shall be turned inward to provide a clean flush exterior finish. All panel seams shall be sealed during assembly to produce an airtight unit.

B. Acoustic Performance:
1. The housing shall have been tested for acoustical performance by an accredited independent laboratory.
2. Test methods and facilities used to establish sound transmission loss values shall conform explicitly with the ASTM designation E90-85 and E413-73.
3. Minimum sound transmission loss (STL) through unit panels shall be as follows:

OCTAVE BAND CENTER FREQUENCY (dB)					
125	250	500	1K	2K	4K
19	27	33	43	53	52

C. Outdoor units shall have seams broken outward to provide a lapped joint watertight seal. Outdoor roofs shall have a minimum of ¼" per foot slope to insure no standing water.

D. Insulation and Interior Liner: Insulation shall be 2" thick, 3 lbs per cubic foot density, neoprene coated fiberglass to cover all walls and ceilings. This insulation shall meet NFPA-90A smoke and flame spread requirements. There shall be no raw edges of insulation exposed to the air stream. Insulation systems using stickpins or adhesives are not acceptable. The entire interior of all units shall be lined with minimum 22 gauge bright galvanized steel liner. The interior liner of the fan sections, inlet plenum sections, and discharge plenum sections shall be perforated and the remaining shall be steel.

E. Stiffeners of angle steel shall be supplied as required to maintain casing deflection criteria of 1/200 at 1.5 times the working pressure. If panels cannot meet this deflection, an additional internal reinforcing shall be added.

F. The manufacturer shall provide 1" capped floor drain connections on the side of the unit for complete drainability of the base pan for the following sections:
   1. Fresh air plenums
   2. Economizer sections
   3. Fan sections
   4. Sections upstream and downstream of coils

G. Paint Finish: After final assembly, the unit exterior shall be coated with an industrial grade high solids polyurethane paint. In addition, all fan bases, springs and structural steel supports shall be coated with the same finish. The paint system shall meet AISTM B Salt spray test for 5000 hours in a 5% solution. Paint shall be applied in an environmentally sealed paint chamber specifically designed for paint application.

2.5 ACCESS DOORS

A. All access doors shall be hinged, double wall, insulated, man size access doors shall be provided in all sections requiring access for maintenance or service. The doors shall be double wall construction with 22 gauge solid metal liner on the inside. Corners of the doors shall be continuously welded for rigidity. 2" 3 lb/cu ft. density insulation shall be sandwiched between the 16 gauge outer layer and the 22 gauge inner layer. Doors MUST be the same thickness as the unit casing to maximize thermal and acoustical resistance. The frame shall be constructed of 16 gauge galvanized steel, fully welded at the corners with finish that matches the casing. The doors shall be fully gasketed with continuous ½" closed cell hollow round black gasketing and a metal encapsulated reinforcing backing that mechanically fastens to the door frame. All hardware provided shall be non-corrosive. Access door must not leak more than 25 CFM @ 6" static pressure.

B. Door hinges shall be continuous piano type stainless steel and shall not require adjustment for the life of the unit.

C. Two [2] "Ventlok" Model #310 high pressure latches operable from either side of the door shall be provided.

D. All doors shall swing against the air pressure (i.e., positive pressure plenum doors must swing in).

E. All access doors shall include a 12" round HERMETICALLY SEALED double glazed laminated glass window.

F. The manufacturer shall provide Duro Dyne IP-4 test ports for unit air stream testing in each access door.

2.6 FANS

A. Supply and return fans shall be direct drive Arrangement #4 plenum fans. Fan wheels shall be aluminum with aluminum extruded airfoil blades. The fan inlet shall be isolated from the cabinet by means of a neoprene-coated flexible connection. Plenum fans shall be provided with spring-style thrust restraints.

B. Each fan shall be sized to perform as indicated on the equipment schedule. The wheel diameter shall not be less than that shown on the equipment schedule. The fan shall be constructed to AMCA Standards for the Class Rating as indicated on the Equipment Schedule.

C. Fan Base, Spring Isolation, and Support Framing: Mount fan and motor on an internal, fully welded, rigid steel base. Base shall be free-floating at all four corners on spring type isolators with earthquake restraints. The fan assembly shall be isolated from the cabinet by steel springs with minimum deflection of 2.0" or as indicated on schedules. The spring isolators shall be mounted to structural steel members. All isolators shall be rated for zone 4 seismic requirements.

D. Balancing: The fan shaft shall be sized for first critical speed of at least 1.43 times the maximum speed for the class. The critical speed will refer to the top of the speed range of the fans' AMCA class. The lateral static deflection shall not exceed 0.003" per foot of the length of the shaft. Fans shall be balanced to ISO standard G6.3. A copy of the balance test data for this project showing calculations for deflection and critical speed of the shaft and wheel assembly shall be submitted to the engineer and a copy forwarded to the Owner.

E. Bearings shall be heavy duty, grease lubricated, anti-friction ball or roller, self-aligning, pillow block type and selected for minimum average bearing life in excess of 200,000 hours at the maximum class RPM.

F. Plenum fan assembly must have an enclosed safety screen built per OSHA Standards. Fans shall have OSHA approve inlet screens.

G. Hoist Rail: Provide I beam hoist rail above fan section access doors to remove motors 10 HP and above. An optional extendable arm to be provided to transport the motor to the unit exterior.

H. Provide factory mounted gravity backdraft dampers for all fans.

I. Fan Airflow Measurement:
   1. Supply air and return air shall be measured by a FreeFlo Sensing Ring as manufactured by Haakon (piezo ring). The flow measuring station shall not obstruct the inlet of the fan and shall have no effect on fan performance (flow or static) or sound power levels. The airflow stations shall be accurate ±3% of actual fan airflow and shall be capable of producing steady, non-pulsating signal of the velocity pressure, independent of the upstream static pressure without adversely affecting the performance of the fan.

J. Fan Airflow Display:
   1. Provide on indicated fans a method of displaying digitally, in real time, the fans current airflow.
   2. The display shall be capable of showing the airflow of two (2) independent fan simultaneously.

3. For interaction with a controller, the display shall output one (1) 0-10VDC signal for each fan being monitored.
4. The display shall require no maintenance throughout its life.
5. The output signal shall be accurate to ±8.5% of Natural Span, including non-linearity, hysteresis and non-repeatability.
6. The display must be water tight allowing for use in outdoor locations. If the display is not water tight it shall be enclosed in a weatherproof housing.

2.7 MOTORS AND DRIVES

A. All motors and drives shall be factory-installed and run tested.

B. Refer to Specification Section 230513 COMMON MOTOR REQUIREMENTS for additional requirements.

C. All motors and drives shall be factory-installed and run tested. Motors shall be premium efficiency, TEFC, NEMA frame, ball bearing type motors.

D. Fan motors shall be factory wired to an external VFD with flexible conduit of adequate length so that it will not have any effect on the vibration isolation.

E. Provide motor shaft grounding for all motors connected to VFDs.

2.8 COILS

A. All coils shall be of the plate fin extended surface type. Tubes shall be 5/8" outside diameter seamless copper with a 0.020" minimum wall thickness. Each coil shall have individually replaceable return bends of 0.025" wall thickness on both sides of the coil. Coils incorporating a "hairpin" type design are not acceptable. Tubes shall be expanded into the fin collars to provide a permanent mechanical bond.

B. The secondary surface shall be formed of 0.006" aluminum fins and shall be spaced not closer than 10 fins per inch with integral spacing collars that cover the tube surface. Headers shall be non-ferrous seamless copper, outside the air stream and provided with brazed copper male pipe connections. Drain and vent tubes shall be extended to the exterior of the air handling unit.

C. All coils shall have counter flow construction. Provide left or right hand coil connections as shown and coordinated with the bid documents and submitted for review. The use of internal restrictive devices to obtain turbulent flow will not be accepted.

D. Coil casings shall be of minimum 16-gauge, 316 stainless steel with double-formed 1-1/4" stacking flanges and 3/4" flanges on the side plates. Flanged tube sheets shall have extruded tube holes to prevent raw edges of tube sheets cut into copper tubes because of thermal expansion of tubes in tube holes. Tube holes with raw sheet metal edges are not acceptable. Reinforcing shall be furnished so that the unsupported length is not over 60". All coil assemblies shall be tested under water at 300 psi and rated for 150-psi working pressure. Headers are to be located inside the cabinet casing with only the pipe connections extending through the casing. All sides of coils shall be carefully blanked off with the same materials used for the coil casings, to ensure all air passes through the coil.

E. Intermediate condensate pans are to be furnished on multiple coil units and single coils greater than 48" high. The pans shall be 16Ga. 316 stainless steel and drain to the main drain pan through stainless steel downspouts.

F. All water coils shall be rated in accordance with ARI Standard 410.

2.9 PRIMARY DRAIN PANS

A. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements.

B. Cooling coil section shall be provided with a 16 gauge, 316 stainless steel drain pan. The drain pan shall be insulated beneath the surface with 2.0", 2-part polyurethane insulation to prevent condensation under the drain pan.

C. Coil support members inside the drain pan shall be 10 gauge, #316 stainless steel.

D. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

E. All drain pan threaded connections shall be visible external to the unit and shall discharge at the side of the unit.

F. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2-inch beyond the base to ensure adequate room for field piping of condensate traps.

G. Provide left or right hand coil connections as shown and coordinated with the bid documents and submitted for review.

2.10 FILTERS

A. Filter sections shall be fabricated as part of the air-handling unit. Filters shall be arranged for upstream loading as shown on the drawings. Provide filter-holding frames to accommodate scheduled filters. Filter frames shall be 16 Ga. galvanized steel with gaskets and two heavy duty positive sealing fasteners and shall be fully welded to reduce leakage of air through corners. Each fastener shall be capable of withstanding 25 lbs. pressure without deflection and be attached or removed without the use of tools. Internal blank-offs shall be provided by the air handling unit manufacturer as required to prevent air bypass around the filters.

B. All air filters shall be State Fire Marshal approved and listed type. Preformed filters having combustible framing shall be tested as a complete assembly. Air filters in all occupancies shall be Class 2 or better, as shown in the State Fire Marshal listing. Air filters shall be accessible for cleaning or replacement.

C. Pre-filters shall be 2" deep, 30% efficient, MERV 8 extended surface pleated filters. Frames shall be recyclable, moisture resistant clay coated board with diagonal and horizontal support members on the upstream and downstream sides, and shall have interlocking corner tabs.

D. Final filters shall be 12" deep, 95% efficient, MERV-14 final filters V-style, extended media area, plastic enclosing frame and disposable. Air filters shall be Camfil Durafil ES or equal, and shall have average efficiency of not less than 95% when tested in accordance with ASHRAE 52-76 test standard.

E. Filters shall be of the quantities and sizes as indicated on the drawings.

F. Provide one set of additional startup pre-filters.

G. Provide factory installed Setra 267 digital filter gauge with LCD display or Engineer approved equal at each filter bank.
   1. Gauge shall be complete with static pressure tips, hardware and fittings.
   2. Enclose the gauge in a protective sheet metal box with a hinged inspection door. Paint to match unit.
   3. Provide IP65/NEMA 4 rated enclosure. All transmitters shall be mounted outside the unit for access.

2.11 ECONOMIZER, MINIMUM OSA, RETURN and RELIEF AIR DAMPER SECTION

A. Economizer section shall include dampers for return air, fresh air and exhaust air. Dampers shall be parallel blade type. Dampers shall be sized for not greater than 1200 fpm face velocity based upon gross damper area. Furnish full height 24" wide access doors for damper and linkage service.

B. Dampers shall be supplied with low leak 12 gauge extruded aluminum airfoil blades. Blades shall be supplied with rubber edge seals and stainless steel arc end seals. Rubber edge seals shall be backed by the damper blade to assure a positive seal in the closed position. Dampers shall be provided with nylon bearings within extruded openings. Pivot rods shall be 7/8" hexagon extruded aluminum interlocking into blade section. Bearings shall be of a double sealed type with a Celcon inner bearing on a rod within a Polycarbonate outer bearing inserted into the frame to prevent the outer bearing from rotating. The bearing shall be designed so there are no metal-to-metal or metal-to-bearing riding surfaces. The interconnecting linkage shall have a separate Celcon bearing to eliminate friction inside the linkage. Blade linkage hardware shall be installed in a frame outside the airstream. All hardware shall be of non-corrosive, reinforced cadmium plated steel. Damper leakage shall not exceed 6 CFM/ft2 at 5.0" of static pressure. Leakage testing shall be in accordance with AMCA standard 500 figure 5.5. Test results must be from independent testing laboratory.

C. Provide louvers for outside air and exhaust air for units located outdoors. OSA Louvers shall be sized for a maximum face velocity of 750 fpm and exhaust air louvers shall be sized for a maximum face velocity of 800 fpm based on gross louver area. Louvers shall have zero water penetration at 600-ft/min air velocity. Maximum louver pressure drop shall be 0.03" in w. g. at 700 ft/min. Provide test results from independent testing laboratory. Test must be conducted in accordance to AMCA Standard 500 figure 5.5. Louver water carry over must be less than 0.01 oz/ft2 at 1100 ft/min of free louver area. Test must be conducted by independent testing laboratory per AMCA 500-89 figure 5.6. Hoods in lieu of louvers are not acceptable.

D. Damper shall be heavy duty type.

E. Fresh air and exhaust air hoods shall be provided complete with 0.5" x 0.5" birdscreen and finished to match the color of the units. Hoods shall be of 16 gauge galvanized steel construction. Continuous rain gutters with drain connections around the perimeter of the hood shall be provided.

2.12 MINIMUM OUTSIDE AIR DAMPER AND AIR FLOW MONITORING SECTION

A. The minimum OSA dampers shall have individual EBTRON, Inc "Gold Series" Model GTC116-PC airflow measuring devices or equal.

B. Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, 32 bit microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor nodes contained in one or more probe assemblies per measurement location.

C. Probes shall be constructed of extruded, gold anodized, 6063 aluminum tubes. All internal wires within the tube shall be Kynar coated. PVC insulated conductors are not acceptable.

D. Each sensor node shall contain two individually wired, hermetically sealed bead-in-glass thermistors.

E. Thermistors shall be mounted in the sensor node using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment. Thermistors leads shall not be fastened to the thermistor semiconductor substrate by weld or solder connections. Manufacturer shall provide UL listed, FEP jacketed, plenum rated cable(s) between sensor probes and the remote transmitter.

F. The airflow rate at each sensor node shall be equally weighted and arithmetically averaged by the transmitter prior to output. All integrated circuitry shall be temperature rated as 'industrial-grade'. Submissions containing 'commercial-grade' integrated circuitry are not acceptable.

G. Each sensing node shall be individually wind tunnel calibrated at 16 points to NIST traceable airflow standards. Airflow accuracy shall be +/-2% of Reading over the entire operating airflow range of not less than 0 to 5,000 fpm (25.4 m/s).

H. The transmitter shall have an integral LCD display capable of simultaneously displaying airflow and temperature. Individual airflow and temperature readings of each independent sensor node shall be accessible. The transmitter shall be capable of field configuration and diagnostics using an on-board pushbutton interface and LCD display.

I. The transmitter shall have two isolated and fused analog output signals and one RS-485 network connection. One analog output shall be for velocity and the other for a temperature output or LEED alarm function. All transmitters shall have integral self-diagnostics.

J. Other than the thermistor sensors, no other electronic components shall be located at the sensing node. Signal processing circuitry on or in the sensor probe shall not acceptable.

K. Devices using chip-in-glass, epoxy-coated or diode-case chip thermistors are not acceptable.

L. Devices with RJ-45 connections exposed to the environment or having electronic circuitry mounted in or at the sensor node are not acceptable.

M. Pitot tubes and arrays are not acceptable.

N. Vortex shedding devices are not acceptable.

O. The transmitter shall be mounted outside the unit for access.

2.13 VARIABLE FREQUENCY DRIVES (VFDS)

A. Refer to Specification Section 230514 VARIABLE FREQUENCY MOTOR CONTROLLERS for additional requirements.

B. All standard and optional features, such as VFD bypass or redundant VFD's, shall be included within the VFD enclosure. The VFDs shall be UL listed. The listing shall allow mounting in plenum or other air handling compartments.

C. For redundant VFD's, provide control wiring and control circuitry to manually (or automatically) transfer from main VFD's to redundant VFD when main drive has faulted.

D. Each VFD shall have its own means of disconnect either by circuit breaker or fused disconnect.

E. VFD's shall be mounted on the air handling unit in single NEMA 3R hinged enclosure.
1. VFD input and output power shall be installed in separate conduits.

F. Provide separate motor overload panel with individual motor overloads and factory wired to the motors with a single point of connection for the VFD.

G. An appropriate means of VFD cooling shall be provided for recessed mounted or NEMA 3R Rated enclosures.

2.14 UNIT MOUNTED CONTROLS

A. All controls shall be field installed by the installing temperature controls contractor and coordinated with the new building automation system. These controls shall include all damper actuators, temperature sensors, pressure sensors, air flow measuring sensors, filter switches, smoke and fire detectors as indicated on the control drawings.

B. Electric and electronic controls shall be wired to a terminal block in a sheet metal enclosure located at a common location mounted on the air handling unit. All pressure sensing controls shall be piped to a common point on the unit with 1/4" compression fittings.

C. Wiring for chilled water control valves shall be field supplied by the installing contractor. Control valve wiring shall be extended to an external junction box located near the coil connections with the final wiring connection done by the temperature controls contractor. All control valves and piping specialties shall be provided by the temperature controls contractor and/or piping contractor.

D. Unit shall include factory installed conduit between sections and split for controls ready construction. If the unit requires splitting; junction boxes shall be furnished on each section to allow the control contractor to make final connections in the field. Wiring shall be clearly labeled to allow ease in final interconnections.

E. All controls shall be supplied and installed by the Division 15975 temperature controls contractor. All wiring shall be performed in a U.L. 508 listed shop.

F. Electrical contractor shall bring separate 120/1/60 power for controls.

2.15 ELECTRICAL REQUIREMENTS

A. All wiring shall be performed in a UL 508 listed shop. Provide single source power panels (SSPP's) that are constructed according to CEC regulations and carry a U.L.508 listing and label. The panel shall include a non-fused main disconnect switch covering all fans in each unit, VFD's for variable volume units, and any necessary transformers, Hand–Off–Auto switches, relays and pilot lights for complete operation of the fans in the unit. The single source power panels shall be factory wired to all factory furnished devices such as motors and interlocks.

B. The air handling unit manufacturer, for the purpose of sole source responsibility, shall manufacture all electrical panel assemblies supplied for the air handlers. The air handling unit manufacturer shall be a U.L. 508 listed panel shop.

C. The main control panel shall have access door(s) for direct access to the controls. The panel shall be NEMA type 3R (rainproof) and shall contain a single externally operated, non-fused disconnect, suitable for copper wire up to and including 3" conduit. The electrical contractor shall bring separate 460/3/60 power to the single source power panel.

D. All wiring shall be run in EMT conduit (or flexible when connecting to a motor). Raceways are not acceptable.

E. Provide fluorescent marine style lights in each access section wired to a common weatherproof switch with 60 minute timer mounted adjacent to the supply fan access door. 120V GFI duplex service receptacles shall be installed and wired with the lighting circuit and located at each fan compartment. The electrical contractor shall bring separate 120/1/60 power to this circuit connected at the supply fan GFI outlet.

2.16 ULTRAVIOLET (UV) GERMICIDAL LAMPS

A. The air handling unit manufacturer shall furnish and install, including interconnecting wiring and safety interlocks, a germicidal UVC irradiation system for each air handler. A heavy-duty UVC germicidal irradiation system using short wave UVC germicidal lamps shall be furnished with each air handler.

B. Intensity: The minimal UV energy striking a targeted surface shall be sufficient to destroy a monolayer of common mold and fungi within six hours.

C. Lamps and fixtures are to be installed in sufficient quantity and in such a manner to ensure equal distribution of UV energy across the cooling face and drain pans.

D. Lamps: Each lamp shall contain no more than 8 milligrams of mercury consistent with current environmental practices and shall be capable of producing its specified output in temperatures of 55 - 135° and airflow velocities up to 1000 fpm. Useful lamp life shall be 9,000 hours with no more than 20% output loss at the end of one year, continuous use. Lamps shall be constructed of UV proof metal bases and shall not product ozone or other secondary contamination.

E. Fixtures: Each fixture shall be constructed of stainless steel. Galvanized steel or aluminum is not acceptable. All integral parts of the fixture shall be self-contained. Fixtures constructed to UL drip proof design and equipped with safety approved fixture-to-fixture plugs to facilitate UL approved multiple fixture and row coupling to A/C power. The UV assembly shall include mechanical interlocks to prevent energizing unless the system is properly installed.

F. Power Supplies: The power supply shall be electronic, high-efficiency type capable of producing the required coverage at no more than 80 watts of power consumption for each four square feet of cross sectional plenum area. Power supply shall be 120 VAC, 60 Hz. Power supply shall be matched to the lamp and designed to maximize photon production, radiance and reliability. Electronic power supply shall be UL listed for application in airstreams between 55 and 135°.

G. Portal: The UV lamp plenum area shall be equipped with a portal for viewing the lamp assembly. Portal shall be constructed to allow viewing without the possibility of exceeding the Minimal Erythermal Dose.

H. Testing and Safety Listing: UV fixtures shall have been tested and listed as UL/C-UL under Category Code ABQK (accessories, air duct mounted), UL Standards 153, 1598 and 1995 respectively, no exceptions. Manufacturer of UVC components shall be ISO 9001 certified.

I. Installation by Air Unit Manufacturer: Air handling unit factory authorized and trained service technicians shall install the tubes in the air-handling units after the units have been installed. UV light manufacturer is to certify installation has been such that UV reflective and shadowed energy losses are the lowest possible. Cumulative sum length of UV fixtures end-to-end shall equal the coil width ± 3 inches. System shall be installed a minimum of 8 inches and maximum of 20 inches from coil surface (based on manufacturer's calculations and recommendations.) One row of lamps shall serve not more than 48 inches of coil height. Installation shall be installed on tracks allowing the UV fixture to slide into place. Tracks shall be designed in such a manner the UV fixture can be easily removed and maintained or replaced. Multiple UV assemblies shall connect via interlock. Fixture rows shall be terminated (for safety) to factory supplied hard-wired module. Light rows shall be mounted so UVC covers the entire coil face and drain pan surfaces as well as line-of-sight airstream. Air unit manufacturer installation shall include all mechanical interlock and wiring to assure UV light assembly is not energized when any access door is opened. For future reference, the air unit manufacturer shall include detailed and certified drawings locating (placing) the fixtures. Drawings shall also be included in all operation and maintenance manuals.

2.17 UNIT SOUND POWER LEVELS

A. Provide sound power level data for the unit that will be supplied.

2.18 ROOF CURB

A. Contractor shall provide roof curb.

B. Roof curb shall be constructed of 12 gauge galvanized steel and manufactured by M.W. Sausse Vibrex Model SRC non-isolated unit or equal approved by DSA.

C. If the contractor substitutes another manufacturer, the contractor shall be responsible for providing structural seismic anchorage calculations and submitting them to DSA for review and approval.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances, and other conditions affecting performance of equipment.

B. Verify that roof is ready to receive Work and opening dimensions are as illustrated by the manufacturer.

C. Verify that proper power supply is available.
Verify that the required mechanical services are in place.

3.2 INSTALLATION

A. Install air handling units and accessories plumb and level in accordance with manufacturer's instructions.

B. Contractor shall install final filters after construction is complete.

C. Contractor shall replace pre-filter after construction is complete.

D. Mechanical contractor shall coordinate with Electrical contractor for:

E. Separate 460v/3ph/60Hz power to the single source power panel.

F. Separate 120v/1ph/60Hz power to the externally mounted light switch and convenience outlet.

G. Separate 120v/1ph/60Hz power to the control panel.

3.3 UNIT SHUTDOWN

A. Contractor shall provide duct smoke detector in main supply air duct from air handling unit or air moving equipment with supply air in excess of 2,000 CFM. Smoke detector shall shut down the air handling unit or air moving equipment when smoke is detected. Connect smoke detector to the building fire alarm system.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect condensate drain pans using pipe sizes indicated on drawings, Type L copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

D. Hot and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Connect piping to air-handling units with flexible connectors.

E. Coordinate duct installations and specialty arrangements with schematics on Drawings and with requirements specified in Section 233113 "Metal Ducts" and Section 233300 "Air Duct Accessories."

F. Connect duct to air-handling units with flexible connections. Comply with requirements of Division 23 Section "Air Duct Accessories."

3.5 FIELD QUALITY CONTROL

A. Contractor shall inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

C. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.

D. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

E. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Contractor shall perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions.

C. Verify that shipping, blocking, and bracing are removed.

D. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.

E. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.

F. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.

G. Verify that zone dampers fully open and close for each zone.

H. Verify that outdoor and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.

I. Comb coil fins for parallel orientation.

J. Install new, clean filters.

K. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

L. Engage a factory-authorized manufacturer's service representative to performance factory certified VFD start-up. Starting procedures for air-handling units include the following:

M. Energize motor; verify proper operation and rotation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.

N. Measure and record motor electrical values for voltage and amperage.

O. Manually operate dampers from fully closed to fully open position and record fan performance.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust.

B. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237416

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. LEED Submittals:
   1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

D. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

B. Warranty

C. Start-up reports

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set(s) for each air-handling unit.

1.7 QUALITY ASSURANCE

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

B. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
   2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period:
      a. For Compressor: Five years from date of Substantial Completion.
      b. For Parts: Two years from date of Substantial Completion.
      c. For Labor: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Mitsubishi

B. Daikin

C. Trane

D. Approved Equal

2.2 INDOOR UNITS

A. Wall-Mounted, Evaporator-Fan Components:
1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. ECM or Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. Enclosure Type: Totally enclosed, fan cooled.
   d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
   e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
   f. Mount unit-mounted disconnect switches on exterior of unit.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Air Filtration Section:
   a. General Requirements for Air Filtration Section:
      1) Comply with NFPA 90A.
      2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
   b. Disposable Panel Filters:
      1) Factory-fabricated, viscous-coated, flat-panel type.
      2) Thickness: 1 inch.
      3) MERV according to ASHRAE 52.2: 4.

2.3 OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Components:
1. 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.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

a. Compressor Type: Scroll.
b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
c. Refrigerant Charge: R-410A.
d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Type ACR, Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. Drain Hose: For condensate.

E. Additional Monitoring:
1. Monitor on/off , status.
2. Monitor cooling load.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure. And as detailed on the drawings.

C. Equipment Mounting:
1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

D. Install and connect (pre-charged) refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 PIPING INSTALLATION

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

B. Install refrigerant piping according to ASHRAE 15.

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

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

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

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

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

J. Slope refrigerant piping as follows:
   1. Install horizontal suction lines with a uniform slope downward to compressor.
   2. Install traps and double risers to entrain oil in vertical runs.
   3. Liquid lines may be installed level.

K. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

E. Prepare test and inspection reports.

3.5 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.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126