

SECTION 22 0500

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Basic Mechanical Requirements specifically applicable to Division 22 Sections, in addition to the general requirements.
- B. Plumbing work includes the following: furnish and install all piping and plumbing fixtures shown on the plumbing, mechanical, and architectural drawings described in these specifications. In connection with this work, contractor shall also furnish and install all necessary work, devices, hardware and systems required to make said systems properly and safely operable, including, but not limited to, support hardware, insulation, valves, flashing, cleanouts, cutting and patching.

1.2 WORK SEQUENCE

- A. Install work in phases to accommodate Owner's construction requirements. Refer to Architectural, Structural, and Electrical Drawings for the construction details and coordinate the work of this division with that of other divisions. Order the work of this division so that progress will harmonize with that of other divisions and all work will proceed expeditiously. During the construction period, coordinate mechanical schedule and operations with General Contractor and any other related subcontractor.
- B. Coordinate related work and modify surrounding work as required.

1.3 SUBMITTALS

- A. Submit on the following:
 - 1. All pipe, fittings, insulation, hangers and supports, labels, fixtures, adhesives and sealants, and equipment that is planned to be installed on this project.
- B. Proposed Products List: Include Products specified in the following Sections:
 - 1. Division 22 - Plumbing.
 - 2. Project Drawings.
- C. Submit product data grouped to include complete submittals of related systems, products, and accessories in a single submittal bound in a three ring binder with table of contents and section tabs. See General Conditions and other sections for additional submittal requirements. Submittals shall clearly identify electrical characteristics, options provided, color, model number and equipment tag as indicated on the drawings.
- D. Equipment and materials shall be ordered only after satisfactory review by Architect and Engineer.
- E. The following statement applies to all items reviewed: "Checking is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the plans and specifications. Contractor is responsible for dimensions which shall be confirmed at the job site; fabrication processes and techniques of construction; coordination of his work with that of other trades; and the satisfactory performance of his work."

- F. Maintain a complete set of the most current reviewed submittal and shop drawings on site during construction.
- G. The first submittal shall be comprehensive and complete. Partial submittals will be returned without review.

1.4 REGULATORY REQUIREMENTS

- A. Conform to 2022 California Building Code.
- B. Fire Protection: Conform to 2022 California Fire Code, and California State Fire Marshall Regulations, Title 19, Public Safety.
- C. Plumbing: Conform to 2022 California Plumbing Code.
- D. Mechanical: Conform to 2022 California Mechanical Code.
- E. Electrical: Conform to 2022 California Electrical Code.
- F. Obtain approved inspections from authority having jurisdiction.
- G. Conflicts: Where conflict or variation exists amongst Codes, the most stringent shall govern.

1.5 PROJECT / SITE CONDITIONS

- A. Install work in locations shown on drawings, unless prevented by project conditions.
- B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other Sections. Obtain permission of Owner before proceeding.
- C. Piping Locations: Piping locations shown are diagrammatic only. Contractor shall verify locations of all lateral stubs, offsets, etc. required in the field. The actual locations of lines, cleanouts and connections may vary provided that complete systems are installed in compliance with codes.
- D. Construction Observation: In addition to the requirement for obtaining inspections by the local jurisdiction, Contractor shall notify Engineer and commissioning agent at appropriate times during the construction process so that they can visit site to become generally familiar with the progress and quality of Contractor's work and to determine if the work is proceeding in general accordance with the contract documents.
- E. Scaling of Drawings: In no case shall working dimensions be scaled from plans, sections, or details from the working drawings. If no dimension is shown on the architectural drawings, the prime Contractor shall request in writing that the Architect or the Engineer provide clarification or the specific dimension.

1.6 QUALITY ASSURANCE

- A. Qualification of Manufacturer: Products used in work shall be produced by manufacturers regularly engaged in the manufacture of similar items.
- B. Qualification of Installer: Use adequate number of skilled workmen, thoroughly trained and experienced in the necessary crafts, and completely familiar with the specified requirements contained in the plans and specifications.

- C. Applicable equipment and materials to be listed by Underwriters' Laboratories and manufactured in accordance with ASME, AWWA, or ANSI standards. Power-using equipment shall meet the California energy efficiency standards as defined in the current Title 24 requirements.
- D. Welding procedures and testing shall comply with ANSI Standard B31.1.0 standard code for pressure piping and the American Welding Society – Welding Handbook. Welding shall also comply with Division of the State Architect and structural plan requirements for materials, procedures, qualifications, and inspections.

1.7 DRAWINGS AND SPECIFICATIONS

- A. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or specifications, the contractor shall immediately and before commencing work, request clarification from Engineer.
- B. The Engineer shall interpret the drawings and the specifications, and the Engineer's decision as to the true intent and meaning thereof and the quality, quantity, and the sufficiency of the materials and workmanship furnished there under shall be accepted as final and conclusive.
- C. In case of conflicts not clarified prior to bidding deadline, use the most costly alternative (better quality, greater quantity, or larger size) in preparing the Bid. A clarification will be issued to the successful Bidder as soon as feasible after the Award, and if appropriate a deductive change order will be issued.
- D. All provisions shall be deemed mandatory except as expressly indicated as optional by the word "may" or "option".
- E. Examine and compare the contract drawings and specifications with the drawings and specifications of other trades. Report any discrepancies to the architect. Install and coordinate the work in cooperation with the other trades.

1.8 DEFINITIONS

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

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Maintain uniformity of manufacturer for equipment used in similar applications and sizes.

- B. Provide products and materials that are new, clean, free from defects, damage, and corrosion.
- C. Provide name/data plates on major components with manufacturer's name, model number, serial number, date of manufacturer, capacity data, and electrical characteristics permanently attached in a conspicuous location on the equipment.
- D. Protect materials stored at site and installed from damage. Verify dimensions of equipment and fixtures prior to ordering. Install all equipment per the manufacturer's instructions for installing, connecting, and adjusting. A copy of the instructions shall be kept at the equipment during installation and provided to the engineer at his/her request.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all equipment per the manufacturer's instructions for installing, connecting, and adjusting. A copy of the instructions shall be kept at the equipment during installation and provided to the engineer at his/her request.
- B. Adjust pipes, ducts, panels, equipment, etc., to accommodate the work to prevent interferences. Provide offsets as needed to avoid other trades.
 - 1. Right-of-Way: Lines which pitch have the right-of-way over those which do not pitch. Lines whose elevations cannot change have right-of-way over lines whose elevations can be changed.
 - 2. Provide offsets, transitions, and changes in directions of pipes as required to maintain proper head room and pitch on sloping lines. Provide traps, air vents, drains, etc., as required. It is the intent of this paragraph that all cost associated with compliance be borne by the contractor.
 - 3. All equipment shall be firmly anchored to building structural elements per DSA approved plans.
 - 4. Carefully check space requirements with other trades and existing conditions to ensure material, fixtures or equipment can be installed in the spaces allotted. Coordination is required and essential.

3.2 FIRESTOPPING

- A. Firestop all penetrations of rated elements with approved firestop material such as Hilti FS-1 per manufacturer's plates. Provide plates to project inspector prior to installation.

END OF SECTION

SECTION 22 05 10

PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, notes, and general provisions of the Contract, including General and Supplemental Conditions, apply to this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings for condensate and gas.
 - 2. Escutcheons.

1.3 REFERENCES

- A. ANSI B31.9 - Building Service Piping.
- B. ASME B16.3 - Malleable Iron Threaded Fittings.
- C. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
- D. ASTM A47 - Ferritic Malleable Iron Castings.
- E. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- F. ASTM A74 - Cast Iron Soil Pipe and Fittings.
- G. ASTM A120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses.
- H. ASTM B32 - Solder Metal.
- I. ASTM B88 - Seamless Copper Water Tube.
- J. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- K. ASTM D1785 - Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- L. ASTM D2241 - Poly Vinyl Chloride (PVC) Plastic Pipe (SDR-PR).
- M. ASTM D2466 - Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
- N. ASTM D2564 - Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
- O. ASTM D2855 - Making Solvent-Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
- P. ASTM D3034 - Poly Vinyl Chloride (PVC) Plastic Sewer Pipe SDR-35.

- Q. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
- R. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.
- S. ASTM D2513 - SDR11.5 Polyethylene Gas Pipe.
- T. ASTM D1784 – Low Extractable Polyvinyl Chloride for filtered water.

1.4 SUBMITTALS

- A. Product Data: For the following products:
 - 1. Piping and fittings.
 - 2. Escutcheons.
- B. Project Record Documents
 - 1. Submit the following:
 - 2. Record actual locations of valves and piping.
- C. Operation and Maintenance Data
 - 1. Submit the following:
 - 2. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.5 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with 2022 California plumbing code.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of the general requirements.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 - PRODUCTS

2.1 CONDENSATE PIPING

- A. Hard Copper Tube: ASTM B88, Type 'L' water tube, drawn temper.

1. Wrought-copper solder-joint fittings: ASME B16.22, wrought-copper pressure fittings, with lead-free solder.
2. Bronze Flanges: ASME B16.24, class 150, with solder-joint ends.
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.
4. All pipe and fittings shall be made in the United States.

2.2 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe:

1. Interior locations - ASTM A53 or A120, Schedule 40 black. US manufactured.
2. Exterior Location - ASTM A53 or A120, Schedule 40 Hot Dipped Galvanized US manufactured.
3. Fittings: At Interior ASME B16.3, black malleable iron, or ASTM A234, forged steel welding type. At exterior ASME B16.3 hot dipped galvanized steel - US manufactured.
4. Joints: NFPA 54, threaded. Sizes 2-1/2" and smaller.
5. Joints: Welded. Sizes 3" and larger.
6. Valves: Provide at each piece of gas-burning equipment, with dirt leg.
7. Protection: Coat exterior gas pipe threads with three coats of cold galvanizing after removing threading oil.

B. Flex Connector:

1. Brasscraft Procoat (Yellow) Stainless Steel, or equal.

2.3 ESCUTCHEONS

A. Escutcheons for water, sewer, and vent piping penetrations of finished surfaces.

1. Manufacturers: subject to compliance with requirements, provide products by the following:
 - a. Brasscraft.
 - b. or equal
2. Description: chrome-plated cast brass with set screws.

PART 3 - EXECUTION

3.1 EXAMINATION

- #### A.
- Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- #### A.
- Ream pipe and tube ends. Remove burrs.
- #### B.
- Remove scale and dirt, on inside and outside, before assembly.
- #### C.
- Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

- #### A.
- Install in accordance with Manufacturer's instructions.

- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide clearance for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors.
- I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- J. Provide support for utility meters in accordance with requirements of utility companies.
- K. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting.
- L. Seal all penetrations through exterior walls and fire rated walls with 3M Firestopping materials for fire rating capacity per the architectural plans and UBC requirements.
- M. Test all piping per 2022 California Plumbing Code Requirements.
- N. As-built locations of pipe with dimensions from easily identified building elements.

3.4 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.
- C. Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.

3.5 ERECTION TOLERANCES

- A. Establish invert elevations. Maintain gradients.
- B. Slope condensate piping and arrange to drain at low points.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:

1. Steel 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.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Equipment supports shall be capable of supporting combined operating weight of supported equipment and connected systems and components.

B. Design seismic-restraint hangers and supports for piping and equipment per 2008 SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems. Hazard level is "A."

C. All exterior steel support components shall be hot-dipped galvanized. All welds shall be ground smooth and painted with three coats of zinc-rich paint.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Mechanical fastener systems.
4. Pipe positioning systems.
5. Trapeze pipe hangers. Include Product Data for components.
6. Metal framing systems. Include Product Data for components.

7. Pipe stands. Include Product Data for components.
8. Equipment supports.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel." Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.
3. Unistrut
4. Superstrut

C. Galvanized, Metallic Coatings: Hot dipped.

D. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

1. Manufacturers:

- a. B-Line Systems, Inc.; a division of Cooper Industries.
- b. Unistrut Corp.; Tyco International, Ltd.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. Power-Strut Div.; Tyco International, Ltd.
4. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated. Exterior components shall be hot-dipped galvanized.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

E. Provide submittal.

2.6 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated (interior use) Type 304 stainless steel (exterior use), for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Anchor must have ICC report. Provide report with submittal and one copy to the inspector. See State Architect Requirements for testing.

1. Manufacturers:

- a. Hilti, Inc.
- b. ITW Ramset/Red Head.
- c. Or equal.

C. Pre-placed concrete inserts

1. Manufacturers:

- a. B-Line Systems, Inc.; a division of Cooper Industries.
- b. or equal.

2.7 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping. See plans for details.
- B. All exterior steel supports shall be hot dipped galvanized.
- C. No piping supports shall be mounted directly on roof membrane.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized. All exterior steel supports shall be hot dipped 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 APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install concrete inserts prior to concrete placement per manufacturer's listing.
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:

G. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface.

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

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

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

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

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

O. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

- c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 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.
3. 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.
4. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Provide 20 gauge sheet metal backing as needed to support equipment and fixture.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports or 4x between framing with Simpson A-34 clips at each side, both ends..

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

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

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING & PERSONNEL PROTECTION

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 1/2 inches below nut.

C. Provide personnel protection at mechanical rooms, equipment areas and any equipment maintenance area from strut and threaded rods ends. Install soft protective materials to prevent skin and skull injuries. Install protection as soon as practicable after installation.

3.6 PAINTING

A. Touch Up: Clean and touch up painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 22 07 00

PLUMBING INSULATION

GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Mineral fiber.
- B. Related Sections include the following:
 - 1. Division 23 Section "HVAC Insulation".

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1.4 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. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 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.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

- B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Armaflex AP

2.2 CONDENSATE AND EQUIPEMENT DRAIN INSULATION SCHEDULE

- A. Condensate Drain Piping:
 - 1. All Pipe Sizes: insulation shall be the following:
 - a. Closed Cell type ½" wall

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation 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.
 - 3. 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 piping including fittings.
- B. 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.

- C. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- D. Keep insulation materials dry during application and finishing.
- E. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- F. Install insulation with least number of joints practical.
- G. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
 - 1. All sealants and adhesives to be field-applied, within the building envelope must comply with VOC limits.

3.4 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings:
 - 1. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

END OF SECTION

SECTION 22 0500

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Basic Mechanical Requirements specifically applicable to Division 22 Sections, in addition to the general requirements.
- B. Plumbing work includes the following: furnish and install all piping and plumbing fixtures shown on the plumbing, mechanical, and architectural drawings described in these specifications. In connection with this work, contractor shall also furnish and install all necessary work, devices, hardware and systems required to make said systems properly and safely operable, including, but not limited to, support hardware, insulation, valves, flashing, cleanouts, cutting and patching.

1.2 WORK SEQUENCE

- A. Install work in phases to accommodate Owner's construction requirements. Refer to Architectural, Structural, and Electrical Drawings for the construction details and coordinate the work of this division with that of other divisions. Order the work of this division so that progress will harmonize with that of other divisions and all work will proceed expeditiously. During the construction period, coordinate mechanical schedule and operations with General Contractor and any other related subcontractor.
- B. Coordinate related work and modify surrounding work as required.

1.3 SUBMITTALS

- A. Submit on the following:
 - 1. All pipe, fittings, insulation, hangers and supports, labels, fixtures, adhesives and sealants, and equipment that is planned to be installed on this project.
- B. Proposed Products List: Include Products specified in the following Sections:
 - 1. Division 22 - Plumbing.
 - 2. Project Drawings.
- C. Submit product data grouped to include complete submittals of related systems, products, and accessories in a single submittal bound in a three ring binder with table of contents and section tabs. See General Conditions and other sections for additional submittal requirements. Submittals shall clearly identify electrical characteristics, options provided, color, model number and equipment tag as indicated on the drawings.
- D. Equipment and materials shall be ordered only after satisfactory review by Architect and Engineer.
- E. The following statement applies to all items reviewed: "Checking is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the plans and specifications. Contractor is responsible for dimensions which shall be confirmed at the job site; fabrication processes and techniques of construction; coordination of his work with that of other trades; and the satisfactory performance of his work."

- F. Maintain a complete set of the most current reviewed submittal and shop drawings on site during construction.
- G. The first submittal shall be comprehensive and complete. Partial submittals will be returned without review.

1.4 REGULATORY REQUIREMENTS

- A. Conform to 2022 California Building Code.
- B. Fire Protection: Conform to 2022 California Fire Code, and California State Fire Marshall Regulations, Title 19, Public Safety.
- C. Plumbing: Conform to 2022 California Plumbing Code.
- D. Mechanical: Conform to 2022 California Mechanical Code.
- E. Electrical: Conform to 2022 California Electrical Code.
- F. Obtain approved inspections from authority having jurisdiction.
- G. Conflicts: Where conflict or variation exists amongst Codes, the most stringent shall govern.

1.5 PROJECT / SITE CONDITIONS

- A. Install work in locations shown on drawings, unless prevented by project conditions.
- B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other Sections. Obtain permission of Owner before proceeding.
- C. Piping Locations: Piping locations shown are diagrammatic only. Contractor shall verify locations of all lateral stubs, offsets, etc. required in the field. The actual locations of lines, cleanouts and connections may vary provided that complete systems are installed in compliance with codes.
- D. Construction Observation: In addition to the requirement for obtaining inspections by the local jurisdiction, Contractor shall notify Engineer and commissioning agent at appropriate times during the construction process so that they can visit site to become generally familiar with the progress and quality of Contractor's work and to determine if the work is proceeding in general accordance with the contract documents.
- E. Scaling of Drawings: In no case shall working dimensions be scaled from plans, sections, or details from the working drawings. If no dimension is shown on the architectural drawings, the prime Contractor shall request in writing that the Architect or the Engineer provide clarification or the specific dimension.

1.6 QUALITY ASSURANCE

- A. Qualification of Manufacturer: Products used in work shall be produced by manufacturers regularly engaged in the manufacture of similar items.
- B. Qualification of Installer: Use adequate number of skilled workmen, thoroughly trained and experienced in the necessary crafts, and completely familiar with the specified requirements contained in the plans and specifications.

- C. Applicable equipment and materials to be listed by Underwriters' Laboratories and manufactured in accordance with ASME, AWWA, or ANSI standards. Power-using equipment shall meet the California energy efficiency standards as defined in the current Title 24 requirements.
- D. Welding procedures and testing shall comply with ANSI Standard B31.1.0 standard code for pressure piping and the American Welding Society – Welding Handbook. Welding shall also comply with Division of the State Architect and structural plan requirements for materials, procedures, qualifications, and inspections.

1.7 DRAWINGS AND SPECIFICATIONS

- A. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or specifications, the contractor shall immediately and before commencing work, request clarification from Engineer.
- B. The Engineer shall interpret the drawings and the specifications, and the Engineer's decision as to the true intent and meaning thereof and the quality, quantity, and the sufficiency of the materials and workmanship furnished there under shall be accepted as final and conclusive.
- C. In case of conflicts not clarified prior to bidding deadline, use the most costly alternative (better quality, greater quantity, or larger size) in preparing the Bid. A clarification will be issued to the successful Bidder as soon as feasible after the Award, and if appropriate a deductive change order will be issued.
- D. All provisions shall be deemed mandatory except as expressly indicated as optional by the word "may" or "option".
- E. Examine and compare the contract drawings and specifications with the drawings and specifications of other trades. Report any discrepancies to the architect. Install and coordinate the work in cooperation with the other trades.

1.8 DEFINITIONS

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

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Maintain uniformity of manufacturer for equipment used in similar applications and sizes.

- B. Provide products and materials that are new, clean, free from defects, damage, and corrosion.
- C. Provide name/data plates on major components with manufacturer's name, model number, serial number, date of manufacturer, capacity data, and electrical characteristics permanently attached in a conspicuous location on the equipment.
- D. Protect materials stored at site and installed from damage. Verify dimensions of equipment and fixtures prior to ordering. Install all equipment per the manufacturer's instructions for installing, connecting, and adjusting. A copy of the instructions shall be kept at the equipment during installation and provided to the engineer at his/her request.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all equipment per the manufacturer's instructions for installing, connecting, and adjusting. A copy of the instructions shall be kept at the equipment during installation and provided to the engineer at his/her request.
- B. Adjust pipes, ducts, panels, equipment, etc., to accommodate the work to prevent interferences. Provide offsets as needed to avoid other trades.
 - 1. Right-of-Way: Lines which pitch have the right-of-way over those which do not pitch. Lines whose elevations cannot change have right-of-way over lines whose elevations can be changed.
 - 2. Provide offsets, transitions, and changes in directions of pipes as required to maintain proper head room and pitch on sloping lines. Provide traps, air vents, drains, etc., as required. It is the intent of this paragraph that all cost associated with compliance be borne by the contractor.
 - 3. All equipment shall be firmly anchored to building structural elements per DSA approved plans.
 - 4. Carefully check space requirements with other trades and existing conditions to ensure material, fixtures or equipment can be installed in the spaces allotted. Coordination is required and essential.

3.2 FIRESTOPPING

- A. Firestop all penetrations of rated elements with approved firestop material such as Hilti FS-1 per manufacturer's plates. Provide plates to project inspector prior to installation.

END OF SECTION

SECTION 23 0500

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Basic Mechanical Requirements specifically applicable to Division 23 Sections, in addition to the General Requirements.
- B. Mechanical work includes the following: furnish and install all mechanical equipment shown on the mechanical, plumbing, architectural, electrical, and civil engineering drawings and described in these specifications. Contractor shall furnish and install, make operable, and test all mechanical equipment shown on the plans. In connection therewith, contractor shall also furnish and install all necessary work, devices, hardware and systems required to make said equipment properly and safely operable, including but not limited to, mounting hardware and framing, insulation, vibration control devices, duct systems, flashing, piping, valves, systems, energy management systems, cutting and patching.

1.2 WORK SEQUENCE

- A. Install work in phases to accommodate Owner's construction requirements. Refer to Architectural, Structural, Civil, and Electrical Drawings for the construction details and coordinate the work of this division with that of other divisions. Order the work of this division so that progress will harmonize with that of other divisions and all work will proceed expeditiously. During the construction period, coordinate mechanical schedule and operations with General Contractor and any other related subcontractor.

1.3 ALTERNATES

- A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner's option. Accepted Alternates will be identified in Owner-Contractor Agreement.
- B. Coordinate related work and modify surrounding work as required.

1.4 SUBMITTALS

- A. Submit the following:
- B. Proposed Products List: Include Products specified in the following Sections:
 - 1. Section 23 - Mechanical.
 - 2. Project Drawings
- C. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal. Submittals shall be specific to the fixtures/device/unit being submitted; the data shall be highlighted or marked to be quite clear as to the fixtures/devices/units that shall be provided.
- D. Equipment and materials shall be ordered only after satisfactory review by Owner and Engineer.
- E. The following statement applies to all items reviewed. "Checking is only for general conformance with the design concept of the project and general compliance with the

information given in the contract documents. Any action shown is subject to the requirements of the plans and specifications. Contractor is responsible for dimensions which shall be confirmed at the job site; fabrication processes and techniques of construction; coordination of his work with that of other trades; and the satisfactory performance of his work."

- F. Contractor shall clearly mark the submittal sheet as to which model number, size, color, etc. when there is more than one choice available.
- G. Maintain a complete set of the most current reviewed submittal and shop drawings on site during construction.
- H. Submittals shall have table of contents organized by specification section and shall clearly identify electrical characteristics, options provided, color, model number and equipment tag as indicated on the drawings.

1.5 REGULATORY REQUIREMENTS

- A. Conform to 2022 California Building Code.
- B. Fire Protection: Conform to 2022 California Fire Code, and California State Fire Marshall Regulations, Title 19, Public Safety.
- C. Plumbing: Conform to 2022 California Plumbing Code.
- D. Mechanical: Conform to 2022 California Mechanical Code.
- E. Electrical: Conform to 2022 California Electrical Code.
- F. Obtain approved inspections from authority having jurisdiction.
- G. Conflicts: Where conflict or variation exists amongst Codes, the most stringent shall govern.

1.6 PROJECT/SITE CONDITIONS

- A. Install work in locations shown on drawings, unless prevented by project conditions.
- B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other Sections. Obtain permission of owner before proceeding.
- C. Piping locations: Piping locations shown are diagrammatic only. Contractor shall verify locations of all lateral stubs, offsets, etc. required in the field. The actual locations of lines, cleanouts and connections may vary provided that complete systems are installed in compliance with codes. It is not the intent of the drawings to show necessary offsets required to avoid structure or other trades. It is the intent of this paragraph that all costs associated with this paragraph be borne by the contractor.
- D. Construction observation: In addition to the requirement for obtaining inspections by the local jurisdiction, contractor shall notify Engineer at appropriate times during the construction process so that Engineer can visit site to become generally familiar with the progress and quality of contractor's work and to determine if the work is proceeding in general accordance with the contract documents.
- E. Scaling of drawings: In no case shall working dimensions be scaled from plans, sections, or details from the working drawings. If no dimension is shown on the architectural drawings, the prime contractor shall request in writing that the architect or engineer provide clarification or the specific dimension.

- F. As equal: For an item to be substituted "as equal" the contractor must provide to the engineer a complete submittal no later than 7 days prior to the bid opening. Contractor shall be responsible for any cost associated with the change including architectural design, mechanical, structural and electrical engineering and changes in any element of the building.
 - G. Unit and duct locations: Heating and air conditioning unit and duct locations shown are approximate only. Contractor shall verify locations of all structural members, other trades, and existing conditions in the field, and locate units and ductwork to avoid interference. All clearances required by unit manufacturer shall be maintained. Entire installation shall be in accordance with codes and the recommended installation procedures published by the manufacturers. It is not the intent of the drawings to show necessary offsets and transitions required to avoid structure or other trades. It is the intent of this paragraph that all costs associated with this paragraph be borne by the contractor.
 - H. Contractor will verify with owner and site conditions the exact existing roofing system in place and provide compatible roofing materials and products. Contractor to provide written statement regarding existing roofing system and proposed roofing system and provide manufacturer information prior to procurement and installation.
 - I. Proceed with roofing work only when existing and forecasted weather conditions will permit a unit of work to be installed in accordance with manufacturer's recommendations and warranty requirements.
 - J. Flashings and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Complete flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
 - K. Patching Materials, General: As required for original installation and to match surrounding construction.
 - 1. Contractor shall provide same products or types of construction as that in existing structure, as needed to patch, extend or match existing.
 - 2. Generally, the Contract Documents will not define products or standards of workmanship present in existing construction. Contractor shall determine products by inspection and necessary testing and determine quality of workmanship by using existing as a sample for comparison.
 - 3. The presence of a product, finish, or type of construction requires that patching, extending or matching shall be performed as necessary to make work complete and consistent with identical standards of quality.
 - L. Patching of Building Finish Materials: Contractor shall match existing products and finishes. Contractor shall confirm colors, patterns, and textures with Architect/Owner. The contractor shall custom cut new materials to fit and to match joint patterns with existing materials. The contractor shall custom cut new materials to size to match existing constructions.
 - M. Patching of Roof: Contractor shall patch and match existing adjacent surface. Where penetrations have occurred to finish surface to remain, contractor shall patch penetrations and repair. Restore exposed finishes of patch areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing. All shall be performed by a licensed roofing contractor.
- 1.7 QUALITY ASSURANCE
- A. Qualification of Manufacturer: Products used in work shall be produced by manufacturers regularly engaged in the manufacture of similar items.

- B. Qualification of Installer: Use adequate number of skilled workman, thoroughly trained and experienced in the necessary crafts, and completely familiar with the specified requirements contained in the plans and specifications. Engage an experienced installer to perform work who has specialized in installing roofing similar to that required for this project; who is approved, authorized, or licensed by the roofing system manufacturer to install manufacturer's product; and who is eligible to receive the standard roofing manufacturer's warranty.
- C. Maintain uniformity of manufacturer for equipment used in similar applications and sizes.
- D. Provide products and materials that are new, clean, free from defects, damage, and corrosion.
- E. Provide name/data plates on major components with manufacturer's name, model number, serial number, date of manufacturer, capacity data, and electrical characteristics permanently attached in a conspicuous location on the equipment.
- F. Applicable equipment and materials to be listed by Underwriters' Laboratories and manufactured in accordance with ASME, AWWA, or ANSI standards. Power using equipment shall be meet the California energy efficiency standards as defined in the current Title 24 requirements.

1.8 DRAWINGS AND SPECIFICATIONS

- A. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or specifications, immediately and before commencing work, request clarification from Engineer.
- B. The Engineer shall interpret the drawings and the specifications, and the Engineer's decision as to the true intent and meaning thereof and the quality, quantity, and sufficiency of the materials and workmanship furnished thereunder shall be accepted as final and conclusive.
- C. In case of conflicts not clarified prior to Bidding deadline, use the most costly alternative (better quality, greater quantity, or larger size) in preparing the Bid. A clarification will be issued to the successful Bidder as soon as feasible after the Award and if appropriate a deductive change order will be issued.
- D. All provisions shall be deemed mandatory except as expressly indicated as optional by the word "may" or "option".
- E. Examine and compare the contract drawings and specifications with the drawings and specifications of other trades. Report any discrepancies to the architect. Install and coordinate the work in cooperation with the other trades.

PART 2 – NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all equipment per the manufacturer's instructions for installing, connecting, and adjusting. A copy of the instructions shall be kept at the equipment during installation and provided to the engineer at his/her request.
- B. Adjust pipes, ducts, panels, equipment, etc., to accommodate the work to prevent interferences.

1. Right-of-Way: Lines which pitch have the right-of-way over those which do not pitch. Lines whose elevations cannot change have right-of-way over lines whose elevations can be changed.
 2. Provide offsets, transitions, and changes in directions of pipes and ducts as required to maintain proper head room and pitch on sloping lines. Provide traps, air vents, drains, etc., as required.
- C. All equipment shall be firmly anchored to building structural elements.
- D. Install all equipment to permit proper service of equipment. Arrange pipes, ducts, conduits, etc to allow accessibility to equipment.
- E. Do not install equipment, pipes, or ducts above electrical room
- F. Install accessible plumbing fixtures at height shown on architectural drawings. Report any discrepancies or layout issues to Architect promptly.

3.2 COORDINATION OF WORK

- A. The contract documents establish scope, materials, and quality but are not detailed installation instructions. Drawings are diagrammatic.
- B. The contract documents show the general arrangement of equipment, ductwork, piping, and accessories. Provide offsets, fittings, and accessories which may be required but are not shown on the drawings. Investigate the site and review the other trades installation locations and requirements to determine conditions affecting the work and provide such work and accessories as may be required to accommodate such conditions.
- C. Whenever work interconnects with the work of other trades, coordinate to insure that all parties concerned have the necessary information required for a proper installation.
- D. Provide access doors as required to allow service and accessibility to valves, dampers, coils, etc. Install fire rated access doors in rated assemblies. Coordinate with framing and ceiling contractors.
- E. Furnish and set sleeves for passage of pipes, ducts, and conduits that pass through structural masonry and concrete walls, roofs, floors and elsewhere as required for the proper protection of each item passing through the building elements. See structural drawings for further details.
- F. Install UL Approved firestopping around all pipes, conduits, ducts, etc which pass through rated walls, partitions, and floors in strict accordance with manufacturer's listing and element rating.

3.3 OPERATING INSTRUCTIONS AND OPERATOR TRAINING

- A. Provide two copies of all operating and maintenance manuals to owner. Include parts lists and suppliers' names and phone numbers.
- B. Provide four hours of training to the owner for the proper operation (start-up, operation, and shutdown) and servicing of the installed equipment. Provide three weeks notice to the owner and engineer of the date of the training. Arrange for subcontractors to attend and participate where applicable.

3.4 RECORD DRAWINGS

- A. Maintain on a daily basis at the project site a complete set of record drawings reflecting an accurate dimensional record of all deviations between work shown on the drawing and that actually installed.
- B. Show any changes to specified equipment such as manufacturer, voltage, model number, capacity, etc. on record drawings.
- C. Provide two reproducible copies of the record drawing to the owner.

3.5 COMMISSIONING

- A. At the conclusion of the installation the contractor shall convene a pre-commissioning meeting to review the implementation of the commissioning process.
- B. Contractor shall verify that all building services, gas, electric, water, sewer, and information technologies are functional prior to beginning commissioning.
- C. Immediately correct roof leakage during construction. If the Contractor does not respond within twenty four (24) hours, the owner will exercise right to correct the Work under terms of the Construction of the Contract.
- D. The commissioning team shall comprise the general, mechanical, electrical, controls and plumbing contractors, the project manager, test and balance company, and the mechanical engineer. Provide sample forms for review to the mechanical engineer prior at pre-commissioning meeting.
- E. The commissioning process shall be including function testing all equipment, controls, natural gas, and electrical systems. All testing shall be documented in an item by item report with dates of test, test parameters and results.
- F. Provide commissioning report to project manager within two weeks of completion.

END OF SECTION

SECTION 23 0529

HANGERS AND SUPPORTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Metal framing systems.
 - 2. Fastener systems.
 - 3. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design seismic-restraint hangers and supports for piping and equipment per 2008 SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems. Hazard level is "A."

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Strut and fittings.
 - 2. Fasteners.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."

3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. B-Line Systems, Inc.; A Division of Cooper Industries.
 2. ERICO/Michigan Hanger Co.
- C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Refrigerant Pipe Support Options:
 1. EPDM clamp insert at all pipe clamps at refrigerant piping.
 2. Strut Mount Insulation Couplings (Hydra Zorb Kilo Shure 7 Series or similar)

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. B-Line Systems, Inc.; a division of Cooper Industries.
 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 3. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: At Interior - Manufacturer's standard finish – At exterior - Hot dipped galvanized.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type interior/exterior steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Install per ICC listing.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
- C. Wood Screws for secure pipe and duct supports to wood structure
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Simpson SDS Screws
 - b. or equal with self drilling feature and ICC report
- D. Sheet Metal Screws
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. TEK Screws
 - b. or equal with self drilling feature and ICC report

2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized. All exterior steel shall be hot dipped aluminized.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Use hangers and supports with hot dipped galvanized, at exterior locations.
- B. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
 - 1. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 - 2. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 - 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 - 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

- C. Saddles and Shields: Unless otherwise indicated and except as specified in piping system sections, install the following types:
 - 1. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- D. Use mechanical-expansion anchors where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- C. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- D. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- E. 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.
- F. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- G. All pipes and ducts shall be braced per 2008 SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems. Seismic hazard level is "A".

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Provide lateral bracing, to prevent swaying, for equipment supports.
- C. Anchor all equipment to resist seismic motion.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces. If material is galvanized spray with cold galvanizing.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply three coats of galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 23 0553

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 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.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

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 EQUIPMENT LABELS

- A. Metal Labels for Exterior Equipment:
 - 1. Material and Thickness: Brass, 0.032-inch (0.8-mm) 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 (64 by 19 mm).

3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Interior Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches (38 mm) high.
- D. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surface of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 23 0593

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, apply to this Section.

1.2 SUMMARY

A. Section Includes:

- 1. Balancing Air Systems:
 - a. Constant-volume air systems.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, Adjusting, and Balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

- A. Certified TAB reports.
- B. Sample report forms.
- C. 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.

1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB, or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.
- B. TAB Conference: Meet with Engineer on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

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 systems for installed 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 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 meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and 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.
- 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 filters and verify that bearings are greased, belts are aligned and tight, 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 are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine 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 strategies and step-by-step procedures where applicable.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.

5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or SMACNA's "HVAC Systems – Testing, Adjusting, and Balancing" and in this Section.
 1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC 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. Crosscheck 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 Division 23 Section "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Adjust using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
3. Manufacturer's name, model number, and serial number.
 4. Motor horsepower rating.
 5. Motor rpm.
 6. Efficiency rating.
 7. Nameplate and measured voltage, each phase.
 8. Nameplate and measured amperage, each phase.
 9. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.7 TOLERANCES

- A. Set HVAC system's air flow 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.

3.8 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare 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.

3.9 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.
- 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 contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 10. Report date.
 - 11. Signature of TAB supervisor who certifies the report.
 - 12. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 13. 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.

14. Nomenclature sheets for each item of equipment.
 15. Data for terminal units, including manufacturer's name, type, size, and fittings.
 16. Notes to explain why certain final data in the body of reports vary from indicated values.
 17. 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 air flow 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. Air flow 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- and Oil-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 air flow 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 air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow 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. Air flow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow 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. Air flow 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.

3.10 INSPECTIONS

A. Initial Inspection:

- 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
- 2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

- 1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer.
- 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Engineer.
- 3. Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- 4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- 5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make any 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 contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 23 0700

HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Insulation Materials:

- a. Flexible elastomeric.
 - b. Mineral fiber.

- 2. Adhesives.

- 3. Sealants.

- 4. Field-applied jackets.

- 5. Tapes.

- 6. Securements.

- 7. Reflective Bubble Wrap

- B. Related Sections:

- 1. Division 22 Section "Plumbing Insulation."
 - 2. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings:
- C. Qualification Data: For qualified Installer.
- D. 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.
- E. Field quality-control reports.

1.4 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. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 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.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS – REFRIGERANT PIPING

- A. Flexible Elastomeric for refrigerant pipes: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials. Glue all joints with manufacturer sealant.
 - 1. Products: Subject to compliance with requirements, include, but are not limited to, the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c.
- B. Pipe supports for Insulated Refrigerant Piping

1. Hydrazorb Klo-Sure 7 series Insulation Couplings
2. For installation of refrigerant piping on strut with strut clamps.

2.2 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Metal Jacket: Install at exterior locations.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.
 2. Corrugated T-304 stainless steel Jacket (0.016") with formed stainless steel fittings.

2.3 SECUREMENTS

- A. Bands:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
 2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, ½ inch.
 3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation 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.
 3. 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, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- 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. Keep insulation materials dry during application and finishing.
- F. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- G. Install insulation with least number of joints practical.
- H. Install all refrigerant piping on strut with Klo-Sure couplings

END OF SECTION

SECTION 23 0802

AIR CLEANING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Disposable panel filters.

1.2 REFERENCES

- A. ANSI/UL 586 - Test Performance of High Efficiency Particulate, Air Filter Units.
- B. ANSI/UL 900 - Test Performance of Air Filter Units.
- C. ASHRAE 52 - Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

1.3 QUALITY ASSURANCE

- A. Filter media shall be ANSI/UL 900 listed, Class 1 or Class 2, as approved by local authorities.
- B. Provide all filters as product of one Manufacturer.
- C. Assemble filter components to form filter banks from products of one Manufacturer.

1.4 SUBMITTALS

- A. Submit product data under provisions of the general conditions on filter media, filter performance data, filter assembly and filter frames.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of the General Conditions.
- B. Include instructions for operation, changing, and periodic cleaning.

1.6 EXTRA STOCK

- A. Provide one set of each size disposable panel filters under provisions of Section the General Conditions for every unit installed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect products under provisions of General Conditions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. FARR MERV 13 FILTERS

2.2 DISPOSABLE, EXTENDED AREA PANEL FILTERS

- A. Media: Pleated, lofted, non-woven, reinforced cotton and synthetic fabric; supported and bonded to welded wire grid; enclosed in cardboard frame.
- B. Rating: ASHRAE 52; 20 percent dust spot efficiency, 85 percent weight arrestance; 500 FPM (2.54 m/sec) face velocity, 0.30 inch WG (75 Pa) initial resistance, 1.0 inch WG (250 Pa) recommended final resistance.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air cleaning devices in accordance with Manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Do not operate fan system until filters (temporary or permanent) are in place. One month after completion of construction replace all filters.
- D. Provide one spare set of filters to owner for every unit.

END OF SECTION

SECTION 23 0803

DUCT CLEANING

PART 1 NOT USED

PART 2 NOT USED

PART 3 EXECUTION

3.01 DUCT CLEANING

- A. Contractor shall review existing conditions at the job site prior to bidding.
- B. Use service openings for entry and inspection. Report promptly to project inspector any damaged or heavily rusted ducting.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access.
 - 2. Provide insulated panels for insulated or lined duct.
 - 3. Patch insulation and liner as recommended by duct liner manufacturer.
 - 4. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 5. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Return-air ducts, dampers, actuators, and turning vanes.
 - 3. Supply-air ducts, dampers, actuators, and turning vanes.
- E. Clean ducting prior to start-up of new units and air balance.
- F. Request inspection by engineer at completion of cleaning. Engineer will inspect random locations for cleanliness and correct duct access patches.
- G. Provide before and after pictures. Provide as-built of locations added for access.
- H. All duct cleaning shall be per the National Air Duct Cleaning Association Standards.

END OF SECTION

SECTION 23 0922

CLIMATE MANAGEMENT CONTROL FOR HVAC

PART 1 - GENERAL

1.1 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. Consult the above for further instructions pertaining to this work. The Contractor is bound by the provisions of Division 01.

1.2 CONTROL SYSTEM DESCRIPTIONS

- A. The Building Automation System (BAS) shall be as indicated on the drawings and described in these specifications. System shall include a network of commercial Internet-programmable thermostats, their accessories, and any other networked devices required for complete climate management. Devices shall communicate across a wireless network using IEEE 802.15.4 technical standards. Wireless communication shall be of an automated mesh communication type, which self-establishes network addresses, communication routes, and all other setup requirements to establish connection across the entire campus. A single Ethernet-connected Gateway shall be able to connect the wireless mesh network to the Internet, allowing for climate management through a cloud based web-application. This network design is to be used to isolate the BAS from the owner's private Ethernet network (LAN) and/or WiFi networks. IEEE 802.11 or any other wireless standard of communication or a wired network communication protocol between devices is not acceptable by these BAS specifications. The Gateway is to connect to a single outbound Ethernet connection on the owner's wide area network (WAN) over a TCP/IP connection. The owner's firewall shall not require any inbound port assignments for the Gateway to connect to the cloud servers. The Gateway shall not require a Public IP and it shall not run any standard available operating systems, such as Windows or Linux.
- B. Access and control of BAS shall be through a web-based graphical management platform. The BAS platform shall sit on a cloud server and be accessible on both local personal computers and remotely by use of a web-browser that supports HTML5 or later.
- C. No on-site servers are to be installed or used for the BAS. No licensing fees or future licensing fees shall be required as part of the BAS. These specifications and guidelines are to create a cohesive and secure network that provides full management over the facility's climate through the cloud BAS.
- D. The BAS shall accommodate an unlimited simultaneous multiple-user operation. Access to the BAS shall be limiting based on security permissions of each operator's role managed by owner site Administrators.

1.3 APPROVED BUILDING AUTOMATION SYSTEM MANUFACTURERS

- A. Pelican Wireless Systems

1.4 SUBMITTALS

- A. Shop drawings and manufacturer's standard specification data sheets on all hardware shall be provided for this project. No work may begin on any segment of this project until the Engineer and Owner have reviewed submittals for conformity with the plan and specifications.
- B. All submittals shall be bound, in a three-ring binder, or provided digitally on a USB stick with a table of contents and related section tabs. Five (5) copies shall be submitted to the Architect or Engineer for distribution and review.
- C. Shop drawings shall include basic floor plans depicting locations of all equipment and wiring (installed by others) to be controlled by system and locations of thermostats, gateways, and other equipment provided under this section. Drawings shall also show location of electrical power, low voltage wiring and data ports, provided by others, required for proper installation of systems of this section.
- D. Submit five (5) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor prior to submitting shall check all documents for accuracy.
- E. The Engineer will make corrections, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.

1.5 SYSTEM STARTUP & COMMISSIONING

- A. Each BAS component in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Documentation shall be provided to the owner that proves installation and testing has been completed and points out any mechanical issues found which are not related to the installation of the BAS. Successful completion of the system tests shall constitute the beginning of the warranty period.
- B. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract to assist with functional testing of system as it relates to the BAS.
- C. Upon completion of installation, submit three (3) copies of record documents. The documents shall be submitted for approval prior to final completion and include:
 - 1. Testing and Commissioning Reports and Checklists signed off by trained field commissioning personnel.
 - 2. Name, address and telephone number of Contractor personnel managing and installing equipment, along with service personnel responsible for supporting the ongoing warranty and services of the control system.

3. Procedures for operating the BAS, including logging on/off, alarm management, reading reports, trends, modification of setpoints, scheduling, and other interactive system requirements.
4. Provide information on how to receive support from Pelican Wireless Systems and communicate that they are a direct supporting resource. Contact information for Technical Support from Pelican Wireless Systems is to be provided.

1.6 CODES AND STANDARDS

- A. Codes and Standards. Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section:
 1. California 2022 Title 24 Compliant
 2. California Energy Commission Occupant Control Smart Thermostat (OCST) certified
 3. OpenADR 2.0 certified

1.7 TRAINING

- A. The BAS Contractor shall provide training for two (2) owner representatives and/or maintenance personnel. The BAS Contractor shall provide on-site training to the District's representative(s) and maintenance personnel per the following description:
- B. On-site training shall consist of a minimum of (1) hours, as indicated above of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include:
 1. System Overview
 2. System Application and Operation
 3. System Access
 4. Application Features Overview
 5. Changing Set Points and other attributes
 6. Scheduling
 7. Editing configurable variables
 8. Graphics
 9. Viewing Historical Reports
 10. Operational sequences including start-up, shutdown, adjusting and balancing
 11. Equipment maintenance

1.8 OPERATING AND MAINTENANCE MANUALS

- A. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS.
- B. Following project completion and testing, the BAS contractor will submit as-built documentation reflecting the exact installation of the system.

1.9 WARRANTY

- A. The BAS contractor shall warrant the system for 12 months after system acceptance and beneficial use by the owner. During the warranty period, the BAS contractor shall be responsible for all necessary revisions as required to provide a complete and workable system consistent with the letter and intent of the Sequence of Operation section of the specification. BAS equipment shall include a limited-warranty by the manufacturer for a period of five (5) years from the time of system acceptance.
- B. Limited-warranty by manufacturer is limited to replacement of defective products.

1.10 WORK BY OTHERS

- A. The BAS Contractor shall coordinate with other contractors prior to performing the work on this project and cooperate as necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work prior to fabrication and installation. The owner's representative shall be immediately notified if an area of conflict occurs between trades prior to fabrication and installation. BAS Contractor shall provide field supervision to the Mechanical Contractor for pre-installation of control components.
- B. Low-voltage thermostat wiring between equipment and thermostat locations shall be furnished and installed by others. Unless otherwise noted all new low-voltage wiring shall be multiple conductor thermostat wiring (wire count as indicated in Thermostat Manufacturer's Installation Instructions) installed per owner's specifications. (Wiring in existing installations shall be minimum three (3) conductor/18-gauge wires per BAS manufacturer's standard specifications, multiple conductor/18-gauge thermostat wiring preferred - see Installation Instructions for specific conductor counts depending on heating and cooling modes of existing equipment.)
- C. Related work provided by others:
 - 1. 110V outlets shall be provided within five (5) feet of each Gateway or Wireless Repeater location.
 - 2. One (1) Ethernet data port shall be provided within ten (10) feet of each Gateway location.
- D. Equipment start-up and servicing.

1.11 SCOPE OF WORK

- A. Except where otherwise noted, the system shall consist of a network of commercial Internet-programmable thermostats, their accessories, and any other networked climate management device(s) required to fill the intent of the specification, sequence of operations, and provide for a complete and operable system.
- B. The BAS contractor shall review and study existing building/site conditions where applicable and all new construction drawings for the project including HVAC drawings and the entire project specifications to familiarize themselves with the equipment and system operation prior to bidding and submittal of a bid/price and notify the owner immediately of any conflicts between the project and the scope of work of this section, including work to be completed by others.

- C. All equipment and installation of control devices associated with the equipment listed below shall be provided under this BAS contractor.
- D. When the BAS is fully installed and operational, the BAS contractor will make themselves available to meet with the designated representatives of the owner to review the as-installed condition of the system. At that time, the BAS contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.
- E. The BAS contractor shall furnish and install a complete BAS control system, including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification.
- F. Provide and install BAS controls for the HVAC Equipment as noted on the drawings.
- G. Provide technical support necessary for commissioning of system in coordination with the HVAC Contractor, Balancing Contractor, and the owner's team.
- H. Shall provide one training session in the operation of the system for owner's personnel.
- I. All work performed under this section of the specifications will be in compliance with all codes and regulations as mandated by the authority having jurisdiction.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Unless otherwise noted, all product shall be of a single manufacturer. The standard of design and quality shall be products as manufactured by Pelican Wireless Systems.

2.2 COMMUNICATION

- A. This project shall be comprised of a network of devices that use an IEEE 802.15.4 self-creating and self-healing wireless mesh communication network to reach an Ethernet Gateway.
- B. The Gateway shall communicate to cloud servers via a single Ethernet connection at the owner's wide area network (WAN) over a TCP/IP connection. The facility's firewall shall not require any inbound port assignments for the Gateway to connect to the cloud servers. The Gateway shall not require a Public IP.
- C. No BACnet, modBus, LON, or any other device-to-device wired communication protocol shall be used in the communication network.

2.3 OPERATOR INTERFACE

- A. The BAS shall be controlled, managed, and configured using a Web-App on any personal computer, smartphone, and/or tablet that runs a browser with HTML5 or newer.

- B. The Web-App platform shall run on cloud servers which allow for virtual access. Platform shall not run on a local on-site server.
- C. The Web-App shall support at a minimum, the following functions:
 - 1. Personal user log-on identifications (email addresses) and unique passwords shall be required.
 - 2. Custom HTML programming shall not be required to display any graphics, data, or build the Web-App. There shall be no development cost, commissioning costs, or software upgrade cost required to obtain and use the Web-App.
 - 3. Storage of historical data shall reside on the cloud server and shall not sit within the client's computer, internal network, or other devices. A BAS, which requires on-site data storage, is not acceptable.
 - 4. System shall allow for administrator and user defined access privileges.
 - 5. A Push/Pull OpenAPI interface with XML data output shall be available.
 - 6. Servers shall not run a Windows operating system.
- D. Control and Override
 - 1. The BAS shall provide view, override, and edit of the status of any object and property in the system. The status of the device shall be defined graphically and shall not require any custom programs or programming.
 - 2. Temporary Overrides. The BAS shall be able to provide temporary override (wherever an override is allowed) and automatically remove the override after a specified period of time.
 - 3. Any override and edit of a object virtually or at the device, if allowable, shall be historically tracked.
- E. Scheduling
 - 1. The BAS shall provide users with scheduling of application devices through a graphical interface. Scheduling shall include, but is not limited to:
 - i. Occupied/Unoccupied Schedules. Shall allow 12 scheduled set-time changes in a single day, be configurable for Daily, Weekly, and Weekday/Weekend layouts, and shall be able to be unique to individual devices or easily shared between multiple devices, where applicable.
 - ii. Event Schedules. Shall allow for advanced one-time or repeating event type schedules. Event schedules shall override Occupied/Unoccupied Schedules. After the Event schedule ends, the device shall revert back to the Occupied/Unoccupied Schedule automatically.
 - iii. Vacation Schedules. A 360-day Calendar shall provide override of schedules during vacation days. Thermostats shall be able to automatically or be manually switched to follow Vacation Schedules instead of Occupied/Unoccupied Schedules.
- F. Alarm Notification
 - 1. Alarm Notification(s) shall be generated if there are failures detected by devices part of the BAS. These failures shall be, but are not limited to: temperature deviations, temperatures missing targets, temperatures too high or too low, failures of equipment, etc. Alarm Notification(s) shall be posted on the BAS and shall be able to be sent either via email or text message to an unlimited number of users.

G. Reports and Logs

1. Data shall be logged and stored on cloud servers for all devices part of BAS in real-time. Every device real-time "state change", when applicable, shall be stored and viewable for at least one week, with the option of up to two (2) years.
 - i. Each space temperature
 - ii. Each temperature set point(s)
 - iii. Each current call: heat, cool, number of stages, fan, economizer, etc.
 - iv. Each damper position
 - v. Each valve position
 - vi. Each CO² change
 - vii. Each CO² setting
 - viii. Each current call for ventilation due to high CO²
 - ix. Each Humidity change
 - x. Each Humidity set point
 - xi. Each current call for dehumidification or humidification.
 - xii. Each Fan speed adjustment
 - xiii. Supply duct static pressure
 - xiv. Supply, Return, Outside air temperatures
2. Data shall be represented on historical graphs that allow for easy viewing of device state change at different times.
3. Excel outputs shall not be required to view data. Historical data shall be viewable through BAS.

2.4 APPLICATION-SPECIFIC CONTROLLERS

- A. Application Specific Controllers shall not require custom programming and shall control specific equipment through simple configuration settings done through the cloud-based BAS. All configuration changes shall automatically upload into the device once set on the BAS and shall be stored by the device's internal memory.
- B. Gateways are devices which connected to an Ethernet port and act as a bridge between the BAS cloud servers and the wireless mesh network.
 1. Shall be capable of providing Internet connection to up to 2,000 devices.
 2. Shall be capable of automatically addressing routing tables to all devices part of wireless mesh network and shall not require manual programming or addressing.
 3. Shall communicate to cloud servers over a TCP/IP outbound-only connection.
 4. Shall not require a Public IP address, custom VPNs, or any on-site servers.
 5. Shall communicate to other BAS devices over the dedicated and isolated 802.15.4 IEEE technical standard.
 6. Shall be secured using AES (Advanced Encryption Standards).
- C. Internet-Enabled Thermostats are controllers which detect a space/zone temperature and operate equipment or dampers which supply heating, cooling, ventilation, or a combination of the three mechanical states, to their space/zone. Examples are thermostats for VAV, VVT, Fan-Powered Boxes, Fan Coil, Blower Coils, Unit Ventilators, Heat Pumps, Water Source Heat Pumps, and Conventional DX and/or Gas heat equipment.

1. Shall be capable of providing 24VAC outputs which can be configured to provide control of the following: two stages of fan, three stages of cooling, two stages of heating, one stage of auxiliary heat (heat pumps), floating point zone dampers, two position zone dampers, floating point zone reheat valves, and two position zone reheat valves.
 2. Shall include a removable wiring terminal module that allows for thermostat installation even in situations where there are only three wires between equipment and where the thermostat is to be installed.
 3. Shall be available with the following internal sensors: temperature only, temperature and humidity, temperature, humidity, and CO², and temperature and CO². All sensors required by the specifications are to be internal to the thermostat and not require two devices on the wall.
 4. Shall be able to accept expansion accessories that allow for more advanced control sequences, and additional temperature detection. Examples are economizer controllers, outside air ventilation control, supply air temperature detection, unit ventilator face/bypass control, and modulating control. All expansion accessories shall be Internet enabled and accessible through EMS.
 5. Shall communicate with the wireless mesh network through an internal wireless antenna that runs on the 802.15.4 technical standards.
 6. Shall be able to automatically repeat the wireless mesh network to additional devices part of the BAS.
 7. Shall automatically push, in real-time, to the BAS all "state changes" so as to be viewable historically and in real-time from BAS. Examples are changes in equipment operation (heat, cool, fan), number of stages active, the temperatures in the space, damper position, valve position, temperature set-points, etc.
 8. Shall be able to lock-out heat pump compressor(s) based on outside air temperature.
 9. Shall provide set-point (heat & cool) temperature limitations through BAS.
 10. Shall provide full local keypad lock-out from BAS.
 11. Shall meet California 2022 Title 24 code standards.
 12. Shall have a programmable three (3°F) degree heat/cool temperature range which auto-adjusts to a five (5°F) degree dead band.
 13. Shall have both a heat setpoint, cool setpoint, and auto-changeover.
 14. Shall have Optimum Start algorithms that will calculate start times based on at least seven (7) days of previous run-time temperature and rate-of-change historical data for its space. Optimum Start algorithm shall recalculate each optimized schedule time before each optimized schedule.
 15. Shall be able to be manually overridden through BAS.
 16. Shall be configured through BAS.
- D. Wired Temperature Inputs are to be available to provide external temperature detection for specific BAS devices. Examples are to provide supply air temperature, water temperature, refrigeration temperature, outside air temperature, etc. to a thermostat or other device.
1. Shall accept 10K type II thermistors.
 2. Shall push to the BAS real-time temperature changes so as to be viewable historically and in real-time from the BAS.
 3. Shall accept a thermistor at a maximum of up to 100 feet from input terminal.
 4. Shall be configured through the BAS.

- E. Internet-Enabled Economizer Controller are controllers that modulate an outside air damper to provide ventilation and economization to a single zone.
1. Shall only require a dry-bulb outside air temperature sensor and dry-bulb supply air temperature sensor. No dry-bulb return air temperature sensor or dry-bulb mixing box temperature sensor shall be required to meet full economizer functionality to at a minimum California 2022 Title 24 standards.
 2. Shall communicate with thermostat to determine space temperature and space temperature setpoint in order to decide when economization can be used.
 3. Shall continue to economize as its only source of cooling as long as the outside air temperature is able to keep the space temperature within 1°F of the cool temperature setpoint.
 4. Shall be able to enable mechanical cooling at the same time as economization.
 5. Shall be able to prevent the supply air temperature from dropping below a minimum temperature.
 6. Shall provide enthalpy by use of pulling humidity and barometric pressure information from the Internet based on the zipcode of installation location. Enthalpy shall not require any additional probes other than the dry-bulb probe and shall be free to enable.
 7. If connected to a CO² thermostat, shall be able to provide demand ventilation control of outside air damper.
 8. Shall have a minimum ventilation damper position and a maximum ventilation damper position.
 9. Shall be able to be scheduled to not open the outside air damper for ventilation during unoccupied hours.
 10. Shall be able to control a Variable Frequency Drive (VFD) with up to five (5) fan speed inputs. Example of fan speed changes are during ventilation, stage one cooling, stage two cooling, stage one heating, stage two heating.
 11. Shall modulate an outside air damper by use of a 0-10VDC signal.
 12. Shall accept a 0-10VDC signal feedback input from the outside air damper actuator to confirm outside air damper is working correctly.
 13. Shall meet all California 2022 Title 24 codes, including Fault Detection and Diagnostic requirements.
 14. Shall send Fault Detection and Diagnostic information to the BAS.
 15. Shall accept a minimum of three (3) 10K type II thermistors.
 16. Shall be able to modulate a 0-10VDC hot water, steam, or electric SCR for heating and outside air tempering.
 17. Shall be able to modulate a 0-10VDC chilled water or modulating DX for cooling and outside air tempering.
 18. Shall be able to control a face/bypass damper.
 19. Shall push all "state changes" to the BAS as to be viewable historically and in real-time from BAS. Examples are changes in equipment operation (heat, cool, fan, economization, ventilation), number of stages active, the supply air temperature, the return air temperature, hot water valve position, face/bypass damper position, variable speed fan setting, etc.
 20. Shall be able to be manually overridden through the BAS.
 21. Shall be configured through the BAS.

- F. Internet-Enabled Power Relay Module are controllers which have dry-contact relays able to start/stop different electrical equipment. Examples are exhaust fans, lights, pumps, valves, boilers, chillers, etc.
1. Shall have relays with a max rating of 120 VAC @ 15 AMPs or 240/277 VAC @ 10 AMPs.
 2. Shall have a low-voltage terminal for momentary contact override inputs. Override time shall be configurable for a specific amount of minutes through a configuration from the BAS.
 3. Shall be able to provide Lead/Lag sequencing between relays.
 4. Shall be able to accept an external dry-contact input used to verify flow if being used as a pump controller. If being used as a lead/lag pump controller, shall be able to alarm the BAS if flow is not detected when Pump A is enabled and start Pump B as a stand-by pump.
 5. Shall communicate with the wireless mesh network through an external wireless antenna that runs on the 802.15.4 technical standards. Antenna shall be able to communicate with Power Relay Module over three (3) 18-gauge wires up to 500 feet between device terminal inputs.
 6. Shall be able to automatically repeat the wireless mesh network to additional devices part of the BAS.
 7. Shall push all "state changes" to the BAS as to be viewable historically and in real-time from the BAS. Examples are changes in relay positions On or Off.
 8. Shall be able to be manually overridden through the BAS.
 9. Shall be configured through the BAS.
- G. Zone Controllers are controllers which operate equipment which supply heating, cooling and ventilation, or a combination of these mechanical states to multiple zones.
1. Shall communicate with the wireless mesh network through a removable wireless antenna that runs on the 802.15.4 technical standards.
 2. Remote mountable antenna shall be able to communicate to Zone Controller over three (3) 18-gauge wires up to 500 feet between devices terminal inputs.
 3. Communication from the Zone Controller to all zone/space Thermostats shall be over the wireless mesh network.
 4. Shall be capable of providing 24VAC outputs which can be configured to provide control of the following: multiple stages of fan, multiple stages of cooling, and multiple stages of heating.
 5. Shall be capable of providing 0-10VDC outputs which can be configured to provide control of the following: variable speed fan (VFD), modulating outside air damper, modulating heating valve.
 6. Shall have integrated outside air damper control logic and not require a third-party or additional controllers to provide economization and ventilation control.
 7. Shall directly accept a supply duct static pressure probe. Shall have an integrated short-term and long-term learning PID loop algorithm for maintaining target supply static configurations. PID loop shall not require any type of cost for programming and is to be factory loaded into controller.
 8. Shall only require dry-bulb outside, return, and supply air temperature sensors.

9. If communicating to CO² thermostat(s), shall be able to provide demand ventilation control of outside air damper.
 10. Shall push all "state changes" to the BAS as to be viewable historically and in real-time from the BAS. Examples are changes in equipment operation (heat, cool, fan, economization, ventilation), number of stages active, the supply air temperature, the return air temperature, the outside air temperature, hot water valve position, supply duct static reading, variable speed fan setting, etc.
 11. Shall be able to be manually overridden through the BAS.
 12. Shall be configured through the BAS.
- H. Make-up Air Controllers which operate equipment supplying ventilation to the building.
1. Shall communicate with the wireless mesh network through a removable wireless antenna that runs on the 802.15.4 technical standards.
 2. Remote mountable antenna shall be able to communicate to Controller over three (3) 18-gauge wires up to 500 feet between devices terminal inputs.
 3. Communication from the Controller to zone/space Thermostat(s) shall be over the wireless mesh network.
 4. Shall be capable of providing 24VAC outputs which can be configured to provide control of the following: multiple stages of fan, multiple stages of cooling, and multiple stages of heating.
 5. Shall be capable of providing 0-10VDC outputs which can be configured to provide control of the following: modulating variable speed fan (VFD), modulating outside air damper, modulating heating, modulating cooling.
 6. Shall be able to modulate a VFD to maintain a targeted building static pressure.
 7. Shall be able to modulate a 0-10VDC hot water, steam, or electric SCR for heating and outside air tempering.
 8. Shall be able to modulate a 0-10VDC chilled water or modulating DX for cooling and outside air tempering.
 9. Shall have integrated outside air damper control logic.
 10. Shall directly accept a building pressure probe. Shall have an integrated short-term and long-term learning PID loop algorithm for maintaining target building pressure. PID loop shall not require any type of cost for programming, is to be factory loaded into controller, and updatable virtually through EMS.
 11. Shall only require dry-bulb outside and supply air temperature sensors.
 12. If communicating to CO² thermostat(s), shall be able to provide demand ventilation control of outside air damper.
 13. Shall push all "state changes" to the BAS as to be viewable historically and in real-time from the BAS. Examples are changes in equipment operation (heat, cool, fan, economization, ventilation), number of stages active, the supply air temperature, the return air temperature, the outside air temperature, hot water valve position, supply duct static reading, variable speed fan setting, etc.
 14. Shall be scheduled On or Off through the BAS.
 15. Shall be able to be manually overridden through the BAS.
 16. Shall be configured through the BAS.

- I. Wireless Proximity Sensors are thermostat accessories which are able to detect when a door or window is opened or closed, or be able to accept a dry-contact input from an occupancy sensor.
 - 1. Shall be able to communicate to a single Internet-Programmable Thermostat over wireless mesh network.
 - 2. Shall communicate with the wireless mesh network through an internal wireless antenna that runs on the 802.15.4 technical standards.
 - 3. Shall run on two AA batteries and not require any unique type of battery to operate.
 - 4. Shall push all "state changes" to the BAS as to be viewable historically and in real-time from the BAS. Examples are if the door is open, if the space is unoccupied, if a window is open.
 - 5. Shall be configured through the BAS.
- J. Remote Wireless Sensors are thermostat accessories which are used to either average temperatures between the sensors location and a master thermostat or to relocate the sensing location of the master thermostat without having to run new wire.
 - 1. Shall be able to communicate to a single Internet-Programmable Thermostat over wireless mesh network.
 - 2. Shall communicate with the wireless mesh network through an internal wireless antenna that runs on the 802.15.4 technical standards.
 - 3. Shall run on two AA batteries and not require any unique type of battery to operate.
 - 4. Shall push all "state changes" to the BAS as to be viewable historically and in real-time from the BAS. Examples are changes in equipment operation (heat, cool, fan), number of stages active, the temperatures in the space, temperature set-points, etc.
 - 5. Shall be configured through the BAS.
- K. Wireless Repeaters are devices which extend the 802.15.4 wireless mesh network across large expanses or where BAS devices are unable to repeat the wireless mesh network on their own. Examples are when bridging the wireless mesh network from one building to another.
 - 1. Shall communicate with the wireless mesh network through an internal wireless antenna that runs on the 802.15.4 technical standards.
 - 2. Shall be able to automatically repeat the wireless mesh network to additional devices part of the BAS.
 - 3. Shall not require an Ethernet connection or any TCP/IP connection.
 - 4. Shall only require a single 120V outlet for power.
 - 5. Indicate location of repeaters on As-Built drawings.
- L. Configuration of Devices and System
 - 1. To meet the sequence of operation for each controller, the controller shall be configured through the BAS by the installing contractor. No custom programming or downloading by use of a service tool shall be required.
 - 2. Stand-Alone Operation: Each piece of equipment specified shall provide stand-alone operation. BAS devices shall not require web connection or communication to the BAS to run under normal operations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The Contract Documents shall be thoroughly examined for coordination of control devices, their installation, wiring, and commissioning. Coordinate and review mechanical equipment specifications, locations, and identify any discrepancies, conflicts, or omissions that shall be reported to the Architect/Engineer for resolution before rough-in work is started.
- B. The BAS manufacturer shall be available to provide assistance to BAS Contractor in order to verify that control equipment can be installed as required, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

3.2 PROTECTION

- A. The BAS installing contractor shall protect all work and material from damage by their work or personnel, and shall be liable for all damage thus caused.
- B. The BAS installing contractor shall be responsible for their work and equipment until final inspection, testing, and acceptance. The BAS installing contractor shall protect their work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.
- C. Installation of BAS shall be performed by an approved Contractor. Approved contractor is one whom either has installed the BAS before or has been approved by the BAS manufacturer. The Contractor shall certify all work as proper and complete. Under no circumstance shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor unless that subcontractor meets the BAS approved Contractor requirements as stated above.
- D. Demolition. Remove controls which do not remain as part of the BAS. The owner will inform the Contractor of any equipment which is to be removed that will remain the property of the owner. All other equipment which is remove will be disposed of by the Contractor.
- E. Access to Site. Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the owner or an owner-approved representative.
- F. Code Compliance. All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations.
- G. Clean Up. During installation, contractor shall maintain a clean environment. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

3.3 TEST AND BALANCE

- A. Testing of controls shall be performed by installing contractor. All equipment and their components being controlled shall be tested, including, but not limited too: heating enables and a proper supply air temperature from the AHU, RTU, and into the zone (if there is a zone box) is recorded, cooling enables and a proper supply air temperature from the AHU, RTU, and into the zone (if there is a zone box) is recorded, fan enables and the proper fan speed is set when specified (when using a multiple speed fan, VFD, or ECM motor), and that the outside air damper fully opens and closes when commanded. Any devices that are enabled and disabled shall properly respond to the BAS control signals.
- B. All control configurations shall be set to meet specifications. All temperatures and other sensors shall be determined accurate and configured for the type of temperature being detected.
- C. All mechanical systems controlled by BAS shall be properly balanced to the right CFMs to meet required codes and specifications.

3.4 WIRING, CONDUIT, AND CABLE

- A. All control wires between mechanical equipment and BAS devices are to be furnished and installed by others, unless BAS contractor is responsible for this part of the installation. The BAS contractor shall not begin work on this contract until all wiring is installed to the satisfaction of the BAS contractor.
- B. It is not an excuse to have not referenced the manufacturer's installation documentation or to have contacted the BAS manufacturer if wire installation is not understood and done incorrectly by the installing Contractor.

3.5 HARDWARE INSTALLATION

- A. Installation Practices for Devices. All devices are to be mounted level/plumb and per the manufacturer's installation documentation.
- B. It is not an excuse to have not referenced the manufacturer's installation documentation or to have contacted the BAS manufacturer if hardware installation not understood and done incorrectly by the installing Contractor.
- C. Identification.
 - 1. Identify all control wires with labeling tape or sleeves using either words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
 - 2. All field enclosures, other than controllers, shall be identified with a nameplate. The lettering shall be in white against a black or blue background.
 - 3. Junction box covers will be marked to indicate that they are a part of the BAS.
 - 4. All field devices (except space sensors) that are not mounted within FIP's shall be identified with name plates.
 - 5. All field devices inside FIP's shall be labeled.
- D. Existing Controls. Existing controls are not to be reused. All BAS devices will be new.

- E. Control System Switch-Over. The installing contractor shall minimize control system downtime during switch-over. Sufficient installation mechanics will be on-site so that the entire switch-over can be accomplished in a reasonable time frame.
- F. Location.
 - 1. The location of sensors is as indicated in the mechanical and architectural drawings.
 - 2. Space temperature, humidity, and CO² sensors will be mounted away from machinery generating heat, direct light, and/or diffuser air streams.
 - 3. If external temperature sensors are installed, sensors will be mounted away from machinery generating heat, direct light, and/or diffuser air streams.
 - 4. If outdoor air temperature sensors are installed, sensors are to be installed such that the effects of heat radiated from the building or sunlight is minimized.

3.6 SYSTEM CONFIGURATION

- A. General. The installing contractor shall provide all labor necessary to install, initialize, start-up and troubleshoot all system hardware and configurations described in this section. This includes any requirements necessary to access the web application on third-party devices.
- B. Installing contractor shall work with owner's representative to determine configuration parameters including but not limited to hours of operation, set points, system variables, naming of devices, and site naming. Naming of devices and the site shall be performed by the installing contractor. Naming convention of space thermostats shall be space served. Naming convention of zone controllers shall be the equipment serial number. All naming shall be provided by or agreed upon with the owner.

3.7 SYSTEM COMMISSIONING AND SYSTEM STARTUP

- A. Each BAS component in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Documentation shall be provided to the owner that proves installation and testing has been completed and points out any mechanical issues found that are not related to the installation of the BAS. Successful completion of the system tests shall constitute the beginning of the warranty period.
- B. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract to assist with functional testing of system as it relates to BAS.
- C. Upon completion of installation, submit three (3) copies of recorded documents. The documents shall be submitted for approval prior to final completion and include:

1. Testing and Commissioning Reports and Checklists signed off by trained field commissioning personnel.
2. Name, address and telephone number of Contractor personnel managing and installing equipment, along with service personnel responsible for supporting the ongoing warranty and services of the control system.
3. Procedures for operating the BAS including logging on/off, alarm management, reading reports, trends, modification of setpoints, scheduling, and other interactive system requirements.
4. Provide information on how to receive support from Pelican Wireless Systems and demonstrate that they are a direct supporting resource. Contact information for Technical Support from Pelican Wireless Systems is to be provided.

END OF SECTION

SECTION 23 1500

VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Flexible Duct Connections

1.2 PERFORMANCE REQUIREMENTS

- A. Provide vibration isolation on motor driven equipment and connected ductwork.

1.3 SUBMITTALS

- A. Submit under provisions of the General Conditions.
- B. Shop Drawings Indoor / Outdoor Units: Indicate and locate vibration isolators with static and dynamic load on each.
- C. Product Data: Provide schedule of vibration isolator type with location and load on each.
- D. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
- E. Manufacturer's Certificate: Certify that the isolators are properly installed and adjusted.

PART 2 - PRODUCTS

2.1 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers

- 1. Ductmate Vinyl Super Duty
- 2. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with Manufacturer's instructions.
- B. At air handling units provide flexible duct connections at connection to existing ducting.
- C. Provide flexible condensate and electrical connections to all equipment.
- D. Adjust springs after installation per Manufacturer's installation instructions

END OF SECTION

SECTION 23 2300

REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Check valves.
- G. Pressure relief valves.
- H. Filter-driers.
- I. Solenoid valves.
- J. Expansion valves.

1.2 RELATED SECTIONS

- A. Section 23 0700 - HVAC Insulation.
- B. Section 23 8126 – Variable Flow Heat Pump.

1.3 REFERENCES

- A. ARI 710 - Liquid Line Dryers.
- B. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter-Driers
- C. ARI 750 - Thermostatic Refrigerant Expansion Valves.
- D. ARI 760 - Solenoid Valves for Use With Volatile Refrigerants.
- E. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- F. ASHRAE 34 - Number Designation of Refrigerants.
- G. ASME - Boiler and Pressure Vessel Codes, SEC 9 Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
- H. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

- I. ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes.
- J. ASME B16.50 – Wrought Copper and Copper Alloy Braze-Joint Pressure Fitting
- K. ASME B31.5 - Refrigeration Piping.
- L. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- M. AWS A5.8 - Brazing Filler Metal.

1.4 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Valves
 - 1. Use factory-supplied service valves on condensing units.
- C. Replaceable Cartridge Filter-Driers:
- D. Solenoid Valves:
 - 1. Use in liquid line of single evaporator systems.

1.5 SUBMITTALS

- A. Submit under provisions of the general requirements.
- B. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
- C. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
- D. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- E. Submit welders certification of compliance.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of the general requirements.
- B. Record exact locations of equipment and refrigeration accessories on record drawings.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of the general requirements.
- B. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts

lists.

1.8 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME SEC 9.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of the general requirements.
- B. Deliver and store piping and specialties in shipping containers with labeling in place.
- C. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- D. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

1.10 WARRANTY

- A. Provide one year warranty under provisions of the general requirements.

PART 2 PRODUCTS

2.1 PIPING

- A. Copper Tubing: ASTM B280, Type ACR annealed.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F (640 to 805 degrees C).
- B. Pipe Supports and Anchors:
 - 1. Conform to Section 23 0529

2.2 REFRIGERANT

- A. Refrigerant: ASHRAE 34
 - 1. R-410.

2.3 REFRIGERANT PIPING

- A. Insulate with closed cell neoprene insulation. Install PABCO or equal T-304 stainless steel corrugated jacketing (0.016) with stainless steel formed fittings at exterior.

PART 3 EXECUTION

3.1 PREPARATION

REFRIGERANT PIPING

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and not interfere with use of space.
- D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Arrange piping to return oil to compressor.
- G. Provide clearance for installation of insulation and access to valves and fittings.
- H. Flood piping system with nitrogen when brazing.
- I. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
- J. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to the general requirements.
- K. Insulate piping and install aluminum jacket at exterior locations.
- L. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- M. Provide replaceable cartridge filter-driers.
- N. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- O. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- P. Fully charge completed system with refrigerant after testing. Test piping and system per manufacturer's requirements.
- Q. Provide electrical connection to solenoid valves.
- R. Seal all exterior penetrations.

END OF SECTION

SECTION 23 3000

SPLIT SYSTEM HEAT PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Outdoor Heat Pump Unit.
- B. Indoor Heat Pump Unit.
- C. Charge of refrigerant and oil.
- D. Controls and control connections.
- E. Refrigerant piping connections.
- F. Motor starters.
- G. Electrical power connections.

1.2 REFERENCES

- A. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- B. ANSI/ASHRAE 90A - Energy Conservation in new Building Design.
- C. ANSI/NEMA MG 1 - Motors and Generators.
- D. ANSI/UL 207 - Refrigerant-Containing Components and Accessories, Non-Electrical.
- E. ANSI/UL 303 - Refrigeration and air-conditioning Condensing, and Air-Source Heat Pump Equipment.
- F. ANSI/UL 465 - Central Cooling Air Conditioners.
- G. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- H. ARI 520 - Positive Displacement Refrigerant Compressors, Compressor Units and Condensing Units.
- I. ASHRAE 14 - Methods of Testing for Rating Positive Displacement Condensing Units.
- J. ARI 270 - Sound Rating of Outdoor Unitary Equipment.

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of the General Conditions.
- B. Submit shop drawings indicating components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Include schematic layouts

showing condensing units, cooling coils, refrigerant piping, and accessories required for complete system.

- C. Submit product data under provisions of the General Conditions.
- D. Submit product data indicating rated capacities, weights specialties and accessories, electrical nameplate data, and wiring diagrams.
- E. Submit design data indicating pipe and equipment sizing.
- F. Submit manufacturer's installation instructions.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of the General Conditions.
- B. Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of the General Conditions.
- B. Store and protect products under provisions of the General Conditions.
- C. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- D. Protect units on site from physical damage. Protect coils.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Outdoor Heat Pump Unit.
 - 1. Manufacturer.
 - a. Samsung
- B. Indoor Heat Pump Unit.
 - 1. Manufacturer.
 - a. Samsung

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide for connection to electrical service.
- C. Provide connection to refrigeration piping system and evaporators. Comply with ANSI/ASHRAE 15. Coordinate condensate drain installation.
- D. Install exterior units on rubber vibration isolation.

- E. Test system for proper operation in all modes. Provide report with discharge temperature in cooling and heating.
- F. Replace filters after 30 days of operation. Verify all operations of unit at this time again. Provide report to owner.

END OF SECTION

SECTION 23 8113

HEAT PUMP WALL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Related Documents:
 - 1. Drawings and general provisions of the Subcontract apply to this Section.
 - 2. Review these documents for coordination with additional requirements and information that apply to work under this Section.
- B. Section Includes:
 - 1. Through-the-wall packaged terminal air conditioning units.
- C. Related Sections:
 - 1. Division 23 Section "Common Results for HVAC".
 - 2. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment".
 - 3. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
 - 4. Refer to Division 23 Section "Common Results for HVAC" for codes and standards, and other general requirements.

1.2 SUBMITTALS

- A. Submit under provisions of Division 23 Section "Common Results for HVAC, Review of Materials.
- B. Submit manufacturer's installation instructions.
- C. Submit manufacturer's descriptive literature, operating instructions, and maintenance and repair data.

PART 2 - PRODUCTS

2.1 WALL MOUNT UNITS MANUFACTURERS (SEE MECHANICAL SCHEDULE)

- A. Marvair. Stainless steel heat exchanger, coated condenser coils, merv 13 filters and R-410. See Mechanical Schedule on M1.1 for further requirements.
- B. Electrical. Provide all needed wire, weathertight conduit, straps, watertight boxes and connections to allow for re-connection to existing electrical power.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate installation of units with owner, mechanical and electrical work.
- B. Supply units fully charged with refrigerant and filled with oil in factory.
- C. Mount wall unit to existing frame providing water tight enclosure to protect ductwork and utility services.
- D. Install new thermostat per schedule on plans. Verify proper operation in all modes. Provide report with discharge temperatures for all units.

END OF SECTION

SECTION 23 8119

HEAT PUMP ROOFTOP PACKAGE UNITS

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Packaged roof-top air conditioning units.

1.2 RELATED SECTIONS

- A. Section 23 07 00 - HVAC Insulation
- B. Section 23 31 13 - Metal Ducts
- C. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC
- D. Division 26 - Equipment Wiring

1.3 SUBMITTALS

- A. Submit under provisions of the General Conditions.
- B. Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. Manufacturer's Installation Instructions

1.4 WARRANTY

- A. Provide one year warranty under provisions of the General Conditions.

1.5 EXTRA MATERIALS

- A. Provide one extra set of filters for each unit.

PART 2 – PRODUCTS

2.1 PACKAGED ROOF TOP AIR CONDITIONING UNITS

- A. Electric heat / cool, integrated economizer with dual enthalpy control, coated outdoor coil, direct drive indoor fan and downflow/ horizontal economizer. Merv 13 filter.
- B. Manufacturers:
 - 1. York

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with Manufacturer's instructions.

- B. Coordinate installation of units with architectural, plumbing, and electrical work.
- C. Provide comprehensive factory start-up. Provide start-up report to engineer for review.
- D. Mount roof mounted unit on curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting frame level also install per approved structural drawings. Provide flexible utility connection. Ductwork connection shall be flexible. Provide curb adapter where needed to fit existing frame.
- E. Install units with seismic restraint brackets.
- F. Provide initial start-up and shut-down. Confirm operation of all functions. Assist air balance contractor.
- G. Replace filters after 30 days of operation. Verify all operations of unit at this time again. Provide report to owner.

END OF SECTION