

SECTION 23 0500 – COMMON HVAC MATERIALS AND METHODS**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. The provisions of the General Requirements, Supplementary Requirements, and Division 1 apply to the HVAC work specified in this Division.
- B. The requirements of this Section apply to the HVAC systems specified in these Specifications and in other Division 23 sections.
- C. Provide all items, articles, materials, equipment, operations and/or methods listed, mentioned, shown and/or scheduled on the Drawings and/or in these Specifications, including all labor, supervision, services, permits, fees, and incidentals necessary and required to provide a complete and operable facility with complete systems as shown, specified, and required by applicable codes.
- D. The work shall include, but not be limited to, the following systems:
 - 1. Fuel supply system.
 - 2. Central heating and cooling equipment.
 - 3. Complete piping systems including insulation, valves, supports, etc.
 - 4. Air handling equipment including packaged equipment and exhaust fans.
 - 5. Air distribution systems including ductwork, terminal units, dampers, insulation, and air inlets and outlets.
 - 6. Condensate drainage system.
 - 7. HVAC control system.
 - 8. Special systems as specified herein.
- E. Advise subcontractor, suppliers, and vendors involved in the work specified in this Section of the applicable requirements.

1.2 QUALITY ASSURANCE

- A. All work and materials shall conform to all applicable local and state codes and all federal, state and other applicable laws and regulations. All clarifications and modifications which have been cleared with appropriate authorities are listed under the applicable sections. All electrical products shall bear the label of a recognized testing laboratory such as UL or CSA..
- B. Whenever the requirements of the Specifications or Drawings exceed those of the applicable code or standard, the requirements of the Specifications and Drawings shall govern.
- C. Codes and Standards: Comply with the provisions of the following referenced codes,

standards and specifications:

1. Federal Specifications (FS)
 2. American National Standards Institute (ANSI)
 3. National Electrical Manufacturer's Association (NEMA)
 4. National Fire Protection Association (NFPA)
 5. Underwriters Laboratories, Inc. (UL)
 6. Factory Mutual (FM)
 7. International Building Code (IBC) with State and Local Amendments
 8. International Mechanical Code (IMC) with State and Local Amendments
 9. Uniform Plumbing Code (UPC) with State and Local Amendments
 10. American Society for Testing and Materials (ASTM)
 11. Americans with Disabilities Act (ADA)
 12. International Fire Code (IFC) with State and Local Amendments
 13. Energy Policy Act (EPAAct)
 14. Manufacturers Standardization Society (MSS)
 15. American Gas Association (AGA)
- D. Each piece of equipment furnished shall meet all detailed requirements of the Drawings and Specifications and shall be suitable for the installation shown. Equipment not meeting all requirements will not be acceptable, even though specified by name. Where two or more units of the same class of equipment are furnished, use product of the same manufacturer; component parts of the entire system need not be products of same manufacturer. Furnish all materials and equipment, new and free from defect and of size, make, type and quality herein specified or approved by the Architect. All materials shall be installed in a neat and professional manner.
- E. All apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.
- F. The Drawings and Specifications are complementary. What is called for by one shall be as though called for by both.
- G. Drawings: Do not scale drawings for roughing-in measurements, nor use as shop drawings. Make field measurements and prepare shop drawings as required. Coordinate work with shop drawings of other specification divisions.
- H. Field Wiring: It is the intent of these specifications that all systems shall be complete and operable. Refer to all drawings and specifications, especially the electrical drawings, to determine voltage, phase, circuit ampacity and number of connections provided. Provide all necessary field wiring and devices from the point of connection indicated on the electrical drawings. All equipment shall be installed in compliance with the Electrical Code and the equipment's UL listing. Bring to the attention of the Architect in writing, all conflicts, incompatibilities, and/or discrepancies prior to bid or as soon as discovered.

1.3 WORK OF OTHER CONTRACTS

- A. Work under this contract shall be conducted in a manner to allow for the future installations of such equipment or items listed in other sections of this Specification.

1.4 WORK OF OTHER DIVISIONS

- A. Work under this Division shall be conducted in a manner to cooperate with the installation of such equipment or items as specified in other Divisions.
- B. Plumbing piping systems and fixtures and fire suppression piping systems are specified under other Divisions of these Specifications except for provisions or items specifically noted on the Drawings or specified herein.
- C. Consult all Drawings and Specifications in this project and become familiar with all equipment to be installed. Coordinate all aspects of the construction with the other trades on the job to ensure that all work and materials required to provide a complete and operational facility are included in the bid.
- D. All sections of Division 23 are interrelated and shall be considered in their entirety when interpreting any material, method, or direction listed in any section of Division 23. Individual sections are not written for specific subcontractors or suppliers but for the General Contractor.

1.5 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES (SUBMITTALS)

- A. Submit in accordance with Division 1 full technical and descriptive shop drawing data on proposed materials and equipment as detailed in each section.
- B. The Contractor shall verify that all equipment submitted can be delivered and installed within the time constraints of the construction period.
- C. Include the manufacturer, type, style, catalog number, complete specification, certified dimensions, and description of physical appearance for each item and option submitted. Reproduction of catalog data sheets shall be clean and legible to show all details, including gauge of metal used.
- D. Include only information on exact equipment to be installed, not general catalogs of the manufacturer. Where sheets show proposed equipment as well as other equipment, identify proposed equipment with rubber stamp arrow or similar concise method.
- E. Submit with each copy a transmittal letter verifying that all included equipment submittals have been carefully considered for quality, dimensions, function, and have been coordinated with the Drawings and Specifications. Guarantee that proposed materials will meet or exceed the quality and function of those specified.
- F. Include field wiring diagrams and connection diagrams for all control and/or low voltage systems, including floor plans.

- G. Submittal Review: The submittal review process is a means to provide quality control. The action noted to be taken (or where conflicts with the contract documents are not noted) shall not be interpreted by the Contractor as automatic "change orders." Approval of the data for substitution and shop drawings shall not eliminate the Contractor's responsibility for compliance with Drawings or Specifications, nor shall it eliminate the responsibility for freedom from errors of any sort in the data discovered prior to or after the review process. Deviations, discrepancies, and conflicts between the submittals and the Contract Documents shall be called to the Architect's attention in writing at the time of transmittal of the data.
- H. Unless otherwise directed by Division 1, submittal data shall be in a 3-ring plastic binder with a clear plastic sleeve and a project identification sheet inserted. Arrange submittals numerically with specification sections identified on divider tabs. All required sections shall be submitted at one time.

1.6 PRODUCT SUBSTITUTION

- A. Materials other than those specified may be approved for this project providing a written request is submitted to the Architect prior to bid in accordance with Instructions to Bidders. Requests shall include complete specifications, dimensions, manufacturer and catalog number for each item for which approval is desired. If, in the opinion of the Architect, the material is not complete or if it is not an acceptable substitute, he may reject it. The Architect's evaluation will be based solely on the material submitted.

1.7 CHANGE ORDERS

- A. All supplemental cost proposals by the Contractor shall be accompanied by a complete itemized breakdown of labor and materials without exception. At the Architect's request, the Contractor's estimating sheets for the supplemental cost proposals shall be made available to the Architect. Labor must be separated and allocated for each item of work.

1.8 RECORD DOCUMENTS

- A. Project Record (As-Installed) Drawings:
1. Maintain a set of record drawings on the job site as directed in Division 1.
 2. Keep Drawings clean, undamaged, and up to date.
 3. Record and accurately indicate the following:
 - a. Depths, sizes, and locations of all buried and concealed piping dimensioned from permanent building features.
 - b. Locations of all valves with assigned tag numbers.
 - c. Locations of all fire dampers and other airflow control devices.
 - d. Changes, additions, and revisions due to change orders, obstructions, etc. Eradicate extraneous information.
 - e. Model numbers of installed equipment.

4. Make Drawings available when requested by Architect for review.
 5. Submit as part of the required Project Closeout documents. Final submittal will be accomplished in Auto Cad.
 6. Quality of entire set of project record drawings to match the quality of the contract documents; quality to be judged by Architect. Computer-aided design drafting (CADD) to complete project record drawings. Use standards set in contract documents. Note field modifications, all addenda, and change order items on project record drawings. If deficiencies are found in either the quality or the accuracy of the drawings, they will be returned unapproved. Additional review of subsequent submissions shall be at the Contractor's expense.
- B. Operating and Maintenance Manuals: Submit five (5) sets of Operating and Maintenance Instructions, including manufacturer's service data, wiring diagrams, and parts lists and vendors for all serviceable items of equipment, valve charts, balancing data, final control diagrams showing final set points, and any additional equipment added by change order, bound in three-ring, vinyl covered, loose-leaf binders organized with index and thumb-tab markers for each classification of equipment or data.
- C. Systems Manual: Submit separate Systems Manual [30] days prior to scheduling the required Instruction Period. The Systems Manual shall be a hard copy binder with fold out full size drawings, and a CD with all data in electronic format. The Document shall contain at minimum the following:
1. Permit/Construction/Design Drawings.
 2. Contractor As-Built Drawings.
 3. A final version of the Basis of Design Document for LEED or Design Build projects.
 4. Single line diagrams for all systems or components that require regular owner adjustment.
 5. As-Built Sequence of Operations, Control Drawings, and Original Set Points for all equipment requiring Contractor programming or set up, including but not limited to;
 - a. Lighting Control Systems.
 - b. HVAC DDC systems.
 - c. HVAC Equipment.
 - d. Plumbing/Pump systems.
 - e. Emergency Power systems.
 - f. All systems specifically required to be Commissioned.
 - g. Minimum set point data to include
 - 1) Seasonal System Adjustments
 - 2) Normal settings for thermostats, fans, VFDs and other motor switching devices.
 - 3) Normal Valve Settings.
 - 4) Original settings for time clocks, schedules, and Lighting Control Panels.
 6. Operating instructions for integrated building systems.
 7. Programing instructions.

8. Recommended schedule of maintenance requirements and frequency.
9. Recommended schedule for retesting of commissioned systems with blank test forms from the original commissioning plan.
10. Recommended schedule for calibrating sensors and actuators.
11. Emergency measures and procedures for systems failures.

1.9 WARRANTY

- A. Furnish, prior to application for final payment, three copies of written and signed guarantee effective a period of one year from date of completion and acceptance of entire project; agree to correct, repair and/or replace defective materials and/or equipment or the results of defective workmanship without additional expense to the Owner. Where no response satisfactory to the Owner has occurred within three working days from the written report of a warranty covered defect, the Contractor shall agree to pay for the cost of repair of the reported defect by a Contractor of the Owner's choice.
- B. Where the manufacturer's guarantee exceeds one year, the longer guarantee shall govern and include the Contractor's labor.

PART 2 - PRODUCTS

2.1 GENERAL

- A. General: Provide all new materials and equipment, identical to apparatus or equipment in successful operation for a minimum of two years. Provide materials of comparable quality omitted here but necessary to complete the work. Maximum allowable variation from stated capacities, minus 5% to plus 10% as approved in each case.
- B. Compatibility: Provide products which are compatible with other portions of the work and provide products with the proper or correct power and fuel-burning characteristics, and similar adaptations for the project.
- C. Efficiency: Heating and cooling equipment shall comply with ASHRAE Standard 90.1-2010 or latest version and the State Energy Code. Where equipment efficiencies are indicated, the use of alternate or substitute manufacturer's equipment with lower efficiencies is not permitted.
- D. Storage and Handling:
 1. Delivery: Deliver to project site with manufacturer's labels intact and legible.
 2. Handling: Avoid damage.
 3. Storage: Inside protected from weather, dirt and construction dust. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping.

2.2 MOTORS

- A. General: Motors shall conform to UL, CSA, and NEMA MG-1 and bear a permanently attached nameplate indicating compliance and motor characteristics. Provide motors meeting UL 507 standard where applicable.
- B. Manufacturers: General Electric, Lincoln, Baldor, Wagner, Westinghouse, US Motors/Emerson or accepted substitute. Where selection of motor manufacturer is within Contractor's control (independent of equipment selection), provide motors produced by a single manufacturer to the greatest extent possible.
- C. Temperature Rating: Class B insulation, except where otherwise indicated or required for service indicated.
- D. Starting Capability: As required for service indicated, but not less than 5 starts per hour.
- E. Phases and Current: 1/3 horsepower and smaller capacitor-start, capacitor-run single-phase; 1/2 horsepower and larger, squirrel-cage induction polyphase. Coordinate with actual current characteristics; specified in Division 16 and use no 230/460 voltage motors on 208 voltage power or vice versa.
- F. Service Factor: 1.15 for polyphase; 1.25 for single-phase.
- G. Construction: General purpose, continuous duty; NEMA design "B," except "C" for high starting torque applications.
- H. Frames: For single phase motor sizes NEMA No. 48, except 56 for heavy-duty applications. NEMA "T" frames for 1 horsepower and larger polyphase motors. Special frame types as required for close coupled pumps and similar applications.
- I. Bearings: Ball or roller, and design for thrust where applicable; double shielded and regreasable, except provide permanently sealed where not accessible for greasing. Sleeve-type bearings permitted only where indicated for fractional (1/6 hp or less) horsepower motors with direct drive loads. Minimum L-10 bearing life of 40,000 hours when used with minimum pitch sheaves per NEMA Table 14-1.
- J. Enclosure Type: Unless otherwise indicated, open drip-proof for normal concealed indoor use, guarded where exposed to employees or occupants. Type II for outdoor use, except weather-protected Type I where adequately housed. Totally enclosed where explosion proof motors are required.
- K. Overload Protection: Built-in thermal with internal sensing device for stopping motor, and for signaling where indicated on single phase motors.
- L. Speed: Not faster than synchronous speeds of 1,800 RPM except on some pumps as approved in each case.
- M. Efficiency: The manufacturer's highest (NEMA premium) efficiency motors tested under procedures recommended by NEMA MG-1 (IEEE Standard 112, Test Method B).

Intermittent duty motors, operating less than 6 hours per day, shall comply with EPCa/EISA standards. Submit manufacturer's data if motor nameplate does not indicate minimum efficiency. Nominal full load efficiencies for 460 volt, 1,800 rpm motors:

HP	Efficiency %
1-1/2	87.5
2	89.5
3	89.5
5	89.5
7-1/2	91.0
10	91.7
15	93.0
20	93.0
25	93.6

- N. Inverter Duty Motors: Where motors are controlled by an adjustable frequency drive, provide motors labeled "Inverter Duty," complying with NEMA MG1-31, and meeting the requirements of the adjustable frequency drive manufacturer.

2.3 STARTERS AND SWITCHES

- A. Manufacturers: Cerus Industrial Model numbers are listed. General Electric, ABB, Allen Bradley, Schneider Electric, Eaton, are approved equal. Provide starters by same manufacturer throughout project.
- B. General: Provide each motor with starter or switch as approved and recommended by manufacturer of motor or equipment of which motor is a part.
- C. System Description
1. Single Phase Starter: Starters for 115VAC single phase motors less than 1 HP shall be capable of both manual and automatic operation. Refer to Section D for single phase starter requirements.
 2. Magnetic Starters: Starters for 3-phase motors shall be magnetic starters. Refer to Section E for magnetic starter requirements.
- D. Enclosed Full Voltage Non-Reversing (FVNR) Single Phase Starter
1. Single Phase Motor Starter Control: The single phase motor starter shall consist of a manually operated quick-make toggle mechanism lockable in the "Off" position which shall also function as the motor disconnect. Additionally, the starter shall provide thermal overload protection, run status pilot light and fault pilot light. The starter must include the capability to operate in both manual and automatic control modes. In automatic mode, the starter shall have the capability to integrate with a building automation system by providing terminals for run input, run status output and fault output. All control terminals shall be integrated in the starter. At a minimum, each single phase starter shall include an interposing run

relay and current sensing status output relay. Single phase motor starter shall be in a surface mount enclosure.

2. Approved manufacturer: Cerus Industrial, model BAS-1P or approved equal.

E. Enclosed Full Voltage Non-Reversing (FVNR) Non-Combination Starter

1. Magnetic Motor Starters shall be enclosed in a general purpose electrical enclosure with the appropriate environmental rating.
2. Starters shall consist of a horsepower rated magnetic contactor with a minimum of 1NO and 1NC auxiliary contacts and solid state electronic overload relay. Overload relay shall protect all three phases with a wide range current setting and trip class to allow field adjustment for specific motor FLA. Overload relay shall provide phase failure, phase loss, locked rotor and stall protection.
3. Provide a manual reset pushbutton on the starter cover to restore normal operation after a trip or fault condition.
4. Each starter shall include an installed 50VA control power transformer (CPT) with protected secondary. The CPT must accept the available line voltage and the control voltage shall not exceed 120V.
5. Installed accessories shall include Hand-Off-Auto operation switch with 22mm style operator interfaces. Include LED pilot light indicators for Hand, Off, Auto, Run and Overload conditions. All pilot devices shall be water tight and dust tight.
6. When remotely controlled by an automation system, the starter shall include remote run terminals which accept both a voltage input signal and a contact closure. The voltage run input shall accept both AC and DC signals including 24VAC, 120VAC, 24VDC and 48VDC to allow direct connection of the transistorized automation signal to the starter.
7. In applications where the motor is interlocked with a damper or valve, the actuator control must reside within the starter enclosure. The starter must provide a voltage output to operate the actuator to open the damper or valve without closing the motor circuit. The starter will only close the motor circuit and start the motor after it has received a contact closure from a limit or end switch confirming the damper or valve position.
8. Manufacturer shall provide and install tags with engraved white lettering to designate equipment served.

F. Quality Assurance

1. Manufacturer shall provide a five year warranty on the complete starter assembly.
2. The starter assembly shall be UL listed under UL 508A.

2.4 GUARDS

- A. Provide guards in accordance with State Safety Code and OSHA requirements over all rotating equipment including belts, shafts and couplings. Drive guards over belts and sheaves shall include 2-1/2" diameter access opening at shaft ends for speed counter.

2.5 DRIVES

- A. Acceptable Manufacturers: Dayton, Gates, Browning.
- B. General: "V" section belt drives, multiple as required. Provide variable pitch motor sheaves on all one or two belt drives and standard slide rails or approved means of adjustment for each motor with belt drive. Use standard section belts and no sheave smaller than cataloged industry standard; provide countersunk center on shaft ends to receive speed counter tip.
- C. Selection: Size drive components based on 1.5 times installed motor horsepower. Where variable frequency drives are provided to modulate motor speed, select drives to allow application of full motor horsepower to the connected load at 60 hertz drive output, up to the maximum rated operating speed of the driven load.

2.6 ACCESS PANELS

- A. Manufacturers: Inryco/Milcor, Bilco, Elmdor, Karp, Potter-Roemer or accepted substitute. Inryco/Milcor Style DW, K, or M panels as required by construction.
- B. Construction: Flush style, fire rated in fire rated partitions and ceilings. Provide flush key cylinder locks on all access panels less than 8' above the floor in public spaces. Turn keys over to Owner at project completion. Screwdriver latches on all others.

2.7 EXPANSION JOINTS AND LOOPS

- A. Flexible Expansion/Seismic Loop: Factory fabricated assembly consisting of two elbows and return bend or three elbows, and two lengths of flexible hose to allow free movement in three axis. Return bend or elbow shall include a drain/vent fitting. Hose shall be corrugated metal style with metal overbraid compatible with the piping materials. Connections to match piping system except connection 2" and larger shall be flanged style. Metraflex "Metraloop" or Unisource "Uni-loops".

2.8 METERS AND GAUGES

- A. General: Install meters and gauges where shown on the plans or specified elsewhere in these specifications.
- B. Pressure-Temperature Test Plugs:
 - 1. 1/4" or 1/2" NPT fitting of solid brass capable of receiving either an 1/8" OD pressure or temperature probe and rated for zero leakage from vacuum to 1000 psig. Neoprene valve core for temperatures to 200 deg. F., Nordel to 350 deg. F.
 - 2. Provide for each test plug a pressure gauge adapter with 1/16" or 1/8" OD pressure probe.
 - 3. Cisco "P/T Plugs," Peterson "Pete's Plug" or approved substitute.
- C. Thermometers: Liquid-in-glass, adjustable stem, separable sockets, plus 40 to 240 degrees F range (unless indicated otherwise). Weiss numbers are listed. Equivalent

Taylor, Trerice, Weksler or approved substitute.

1. Wide case (9") in equipment rooms and all major equipment items. Weiss "9VS" Series.
2. Narrow case (7") in all other locations. Weiss "7VS" Series.

- D. Pressure Gauges: Install on suction and discharge of all pumps and where shown on Drawings 4-1/2" dial, 0-100 psig graduation pressure gauges with Ashcroft No. 1106 pulsation dampers and stop cocks. Weiss NF4UGY-1 or equivalent Ashcroft, Marsh, Trerice, Weksler.

2.9 VALVES

- A. General: Provide factory fabricated valves of the type, body material, temperature and pressure class, and service indicated. Bronze gate, globe and check valves shall comply with MSS-SP-80. Ball valves shall comply with MSS-SP-110. Iron gate and globe valves shall comply with MSS-SP-70. Iron check valves shall comply with MSS-SP-71. Butterfly valves shall comply with MSS-SP-67. Valve size same as connecting pipe size.
- B. Acceptable Manufacturers: Milwaukee, Crane, Grinnell, Nibco, Hammond, Stockham, Legend, Apollo, Watts, and Walworth. Grooved end valves Victaulic, Tyco-Grinnell, Gruvlock, or accepted substitute. NIBCO numbers are given except as noted. Where possible, provide valves from a single manufacturer.
- C. Valve Styles: See individual Division 23 sections for valve styles.
- D. Insulated Valves: Install extended-stem valves in all piping specified as insulated, and arrange in the proper manner to receive insulation.
- E. Selection of Valve Ends (Pipe Connections): Select and install valves with ends matching the types of pipe/tube connections.

2.10 HANGERS AND SUPPORTS

- A. General: Provide factory-fabricated horizontal piping hangers, clamps, hanger rod, inserts, supports, etc., of the indicated MSS type and size. The Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry Practice SP-58 and SP-69 are referenced in this section.
- B. Manufacturers: B-Line, Carpenter & Paterson, Grinnell, Michigan, Superstrut, Tolco, Erico, or accepted substitute. Grinnell figure numbers in parentheses where applicable (or other manufacturers as noted).
- C. Corrosion Protection: Provide materials which are zinc plated or factory painted to prevent corrosion. Prevent electrolysis in the support of copper tubing by the use of hangers and supports which are copper plated, plastic coated, or by other recognized

industry methods.

- D. Seismic Requirements: Provide seismic restraints in accordance with OSSC Section 1613. Design restraint systems in accordance with "Seismic Restraint Manual: Guidelines for Mechanical Systems," Second Edition, 1998, SMACNA, or "A Practical Guide to Seismic Restraint" ASHRAE RP-812, 1999.
- E. Horizontal Piping Hangers and Supports:
1. Adjustable Clevis Hanger: MSS Type 1 (Fig. 260).
 2. Adjustable Band Hanger: MSS Type 7 (Fig. 97), fabricated from steel.
 3. Adjustable Swivel-Band Hanger: MSS Type 10 (Fig. 70).
 4. Clamp: MSS Type 4 (Fig. 212, 216).
 5. Double-Bolt Clamp: MSS Type 3 (Fig. 295A, 295H), including pipe spacers.
 6. Adjustable Saddle-Support: MSS Type 36 (Fig. 258) and MSS Type 37 (Fig. 259), including saddle, pipe and reducer. Fabricate base-support from steel pipe and include cast-iron flange or welded-steel plate.
 7. Channel Support System: Galvanized, 12 gauge channel and bracket support systems, single or double channel as indicated on the Drawings or as required by piping and equipment weights. Grinnell "Power Strut" channel. Acceptable Manufacturers: Super Strut, Globestrut, Erico, Bee, Kindorf or Unistrut.
 8. Rooftop Pipe Stands: MIRO Industries model 24-R, Erico Pipe Pier, PHP, or accepted substitute.
- F. Vertical Pipe Clamps:
1. Two-Bolt Riser Clamp: MSS Type 8 (Fig. 261).
 2. Four-Bolt Riser Clamp: MSS Type 42 include pipe spacers at inner bolt-holes.
- G. Hanger Attachment:
1. Hanger Rod: Rolled threads, zinc plated. Right hand threaded.
 2. Turnbuckles: MSS Type 13 (Fig. 230).
 3. Weldless Eye-Nut: MSS Type 17 (Fig. 290).
 4. Malleable Eye-Socket: MSS Type 16 (Fig. 110R).
 5. Clevises: MSS Type 14 (Fig. 299).
- H. Building Attachments:
1. Concrete Inserts: MSS Type 18 (Fig. 282), steel or Grinnell Power-Strut PS349 continuous channel. Acceptable Manufacturers: Michigan Hanger, Globestrut, Unistrut, Super Strut.
 2. Clamps: MSS Type 19 (Fig. 285, 281), Type 20, 21 (Fig. 225, 226, 131), Type 23 (Fig. 86, 87, 88), Type 25 (Fig. 227), Type 27 through 30 where applicable.

2.11 IDENTIFICATION MARKERS

A. Pipe Markers:

1. Adhesive pipe markers of width, letter size and background color conforming to ANSI A13.1.
2. Acceptable Manufacturers: Brady B946 with arrow banding tape or similar Seaton, Zeston, MSI.

B. Duct Markers:

1. Adhesive duct markers 2¼"x14" with black text indicating contents on white background with directional flow arrow.
2. Acceptable Manufacturers: Brady B946 or similar Seaton, Zeston, MSI.

C. Nameplates:

1. Engraved nameplates, 1/16" thick, laminated 2-ply plastic, bottom ply white, outer ply black, letters formed by exposing bottom ply.
2. Size: 2" by 4" nameplates with 1/4" high letters.

D. Valve Tags:

1. 2" diameter, 18-gauge polished brass tags with 3/16" chain hole and 1/4" high stamped, black-filled service designation.
2. Acceptable Manufacturers: Seaton, Brady, MSI.

2.12 PENETRATION FIRE STOPPING

A. Through-penetration fire stopping system tested and listed by Underwriters Laboratories. Hilti, 3M, Metacaulk, SpecSeal, or approved.

B. Select system for proper application based on wall construction, type of penetrating item, wall rating, etc.

PART 3 - EXECUTION

3.1 LAYOUT AND COORDINATION

A. Site Examination: Before starting work, carefully examine site and all contract Drawings. Become thoroughly familiar with conditions governing work on this project. Verify all indicated elevations, building measurements, roughing-in dimensions and equipment locations before proceeding with any of the work.

B. Utility Locations: The location of existing utilities, wires, conduits, pipes, ducts, or other service facilities are shown in a general way only on the Drawings and are taken from existing records. Ascertain whether any additional facilities other than those shown on

the plans may be present and determine the exact location and elevations of all utilities prior to commencing installation.

- C. Sleeves, Inserts, Cast-in-Place Work: Provide sleeves, inserts, anchoring devices, cast-in-place work, etc. which must be set in concrete sequenced at the proper time for the project schedule.
- D. Coordination:
 - 1. The drawings are based on equipment of a certain manufacturer and may be identified as such. Where alternate manufacturers or approved substitutes are incorporated into the work, any required design changes are the responsibility of the Contractor. Such changes may include changes in utility or system connection sizes, location, or orientation, service clearances, structural support or acoustic considerations.
 - 2. Where the work must be sequenced and positioned with precision in order to fit into the available space, prepare accurate scale shop drawings showing the actual physical dimensions required for the installation and submit prior to purchase/fabrication/installation of any of the elements involved in the coordination.
 - 3. Cooperate with other trades in furnishing material and information for sleeves, bucks, chases, mountings, backing, foundations and wiring required for installation of mechanical items.
 - 4. Coordinate all work with other trades and determine in advance where interfacing of the mechanical work and other work are required to be connected together. Provide all materials and equipment to make those connections. Submit shop drawings showing required connections where special conditions exist.
- E. Discrepancies: Report immediately any error, conflict or discrepancy in Plans, Specifications and/or existing conditions. Do not proceed with any questionable items of work until clarification of same has been made. Should rearrangement or re-routing of piping be necessary, provide for approval the simplest layout possible for that particular portion of the work.

3.2 UTILITY COORDINATION

- A. Utility Coordination: Coordinate all aspects of the incoming utility services indicated with the city engineer, serving utility, and the off-street improvements Contractor. Requirements of the utility company which exceed the provisions made on the Drawings or covered by these Specifications shall take precedence. Provisions made on the Drawings or Specifications in excess of the utility company's requirements shall take precedence. No additional compensation will be allowed the Contractor for connection fees or additional work or equipment not covered in the Drawings or Specifications which are a result of policies of the serving utilities.

3.3 CONTINUITY OF EXISTING SERVICES (REMODELS OR ADDITIONS)

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- A. Existing water, power, heat, ventilation, air conditioning and other services shall remain in service during new construction work. Coordinate any interruption of these services with the Owner's representative a minimum of twenty-four (24) hours in advance. Arrange work to minimize number and extent of all interruptions.
 - B. Protect from damage active utilities existing and evident by reasonable inspection of the site whether shown or not on the Drawings. Protect, relocate or abandon utilities encountered in the work which are not shown on the Drawings or evident by inspection of the work as directed by the Architect. Maintain continuity of all utility services to existing buildings.

3.4 EQUIPMENT REMOVAL (REMODELS)

- A. All removed mechanical equipment is the property of the Contractor unless indicated otherwise. Disconnect and remove all such equipment from the project property. Cap all piping in walls, below floors, and/or above ceilings in finished rooms. Comply with Section 02050, Demolition.
- B. Disable electrical circuits by disconnection of both ends and make safe with wire nuts or other approved methods. Remove wire and conduit to concealed locations.
- C. Reused Equipment: Reconnect piping, wiring and/or controls to restore original equipment functions unless indicated otherwise.

3.5 MECHANICAL EQUIPMENT WIRING

- A. Provide all mechanical equipment motors, automatic temperature, limit, float and similar control devices required, with wiring complete from power source indicated on Electrical Drawings.
- B. Provide properly rated motor overload and undervoltage protection and all manual or automatic motor operating devices for all mechanical equipment.
- C. Equipment and systems shown on the Drawings and/or specified, are based upon requirements of specific manufacturers which are intended as somewhat typical of several makes which may be approved. Provide all field wiring and/or devices necessary for a complete and operable system including controls for the actual selected equipment/system.
- D. Provide all starters for mechanical motors not included in the motor control center. Review Electrical Specifications and Drawings to determine which mechanical motor starters will be provided under the Electrical Specification Sections and provide all others.

3.6 GENERAL INSTALLATION

- A. Locating and Positioning Equipment: Observe all Codes, Regulations and good

common practice in locating and installing mechanical equipment and material so that completed installation presents the least possible hazard. Maintain adequate clearances for repair and service to all equipment and comply with Code requirements.

- B. Arrangement: Arrange piping parallel with primary lines of the building construction, and with a minimum of 7' overhead clearance in all areas where possible. Unless indicated otherwise, conceal all piping. Locate operating and control equipment properly to provide easy access, and arrange entire mechanical work with adequate access for operation and maintenance. Give right-of-way to piping which must slope for drainage. Set all equipment level or as recommended by manufacturer. Under no conditions shall beams, girders, footings or columns be cut for mechanical items. Casting of pipes into concrete is prohibited unless so shown on Drawings.
- C. Drip Pans: Provide drip pans under all above ceiling in-line pumps and cooling coils. Locate pan immediately below piping and equipment, and extend a minimum of 6" on each side and lengthwise 18" beyond equipment being protected. Fabricate pans 2" deep, of reinforced 20 gauge galvanized sheet metal with watertight seams and rolled or hemmed edges. Provide 3/4" drainage piping, piped independently of any cooling coil primary condensate drain, and properly discharged to over floor drain or as shown on the Drawings. Comply with Mechanical Code for overflow protection and pipe sizing.
- D. Access Panels: Provide access panels with proper backing reinforcement for all equipment, dielectric unions, valves and items requiring service and installed above ceilings, behind walls, or in furring, complete with correct frame for type of building construction involved. Exact size, number and location of access panels are not necessarily shown on Drawings. Use no panel smaller than 12" by 12" for simple manual access or smaller than 16" x 20" where personnel must pass through.
- E. Adjusting: Adjust and calibrate all automatic mechanical equipment, temperature controls, float devices, etc. Adjust flow rates at each piece of equipment or fixture.
- F. Building Vapor Barrier: Wherever the building insulation vapor barrier is penetrated by piping, hangers, conduits, etc., provide clear self-adhesive tape recommended by the insulation manufacturer around the penetrations.
- G. Concrete Work: Coordinate with other work, particularly other concrete work and accessories. Comply with applicable provisions of Section 03310 for mechanical work concrete, including formwork, reinforcement, mix design, materials (use mix designs and materials accepted for Division 3 work where possible), admixtures, accessories, (including waterstops), placing of wet concrete, finishing, curing, protecting, testing, submittals and other requirements of the concrete work.
- H. Housekeeping Pads: Construct minimum 3" thick with chamfered edges using 3000 psi concrete. Provide #4 reinforcing bars 8" on center in each direction and within 4" of each edge, centered in pad thickness. Provide 1/2" dowel with 3" embedment into floor slab for each 2 square feet of pad area. Dowels and equipment anchor bolts shall be spaced a minimum of 6" from pad edges.

3.7 VALVE INSTALLATION

- A. General: Comply with the following requirements:
1. Install valves where required for proper operation of piping and isolation of equipment, including valves in branch lines where necessary to isolate sections of piping, and where shown on the drawings. Install valves at low points in piping systems that must be drained for service or freeze protection.
 2. Locate valves in accessible spaces (or behind access panels) and so that separate support can be provided when necessary.
 3. Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward from a horizontal plane.
- B. Insulated Valves: Install extended-stem valves in all piping specified as insulated, and arrange in the proper manner to receive insulation.
- C. Valve Access: Provide access panels to all valves installed behind walls, in furring or otherwise inaccessible.
- D. Lubricant-Seal: Select and install plug valves with lubricant-seal except where frequent usage is indicated or can be reasonably expected to occur.

3.8 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Proceed with the installation of hangers, supports and anchors only after the required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) the proper placement of inserts, anchors and other building structural attachments.
1. Install hangers, supports, clamps, and attachments to support piping and equipment properly from the building structure. Use no wire or perforated metal to support piping, and no supports from other piping or equipment. For exposed continuous pipe runs, install hangers and supports of the same type and style as installed for adjacent similar piping.
 2. Prevent electrolysis in the support of copper tubing by the use of hangers and supports which are copper plated or by other recognized industry methods.
 3. Support fire sprinkler piping independently of other piping and in accordance with NFPA Pamphlet 13.
 4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at panel points only.
- B. Provisions for Movement:
1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units. Install

specified seismic restraints to restrict excessive movement.

2. Install hangers and supports so that equipment and piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
3. Install hangers and supports to provide the indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 are not exceeded. Comply with the following installation requirements:
 - a. Clamps: Attach clamps, including spacers (if any), to piping outside the insulated piping support. Do not exceed pipe stresses allowed by ANSI B31.
 - b. Insulated Pipe Supports: Insulated pipe supports shall be supplied and installed on all insulated pipe and tubing.
 - c. Load Rating: All insulated pipe supports shall be load rated by the manufacturer based upon testing and analysis in conformance with ASME B31.1, MSS SP-58, MSS SP-69 and MSS SP-89.
 - d. Support Type: Manufacturer's recommendations, hanger style and load shall determine support type.
 - e. Insulated Piping Supports: Where insulated piping with continuous vapor barrier or where exposed to view in finished areas is specified, install hard maple wood insulation shields (Elcen Fig. 216) or steel pipe covering protection shields (MSS type 39) at each hanger.

C. Pipe Support:

1. Vertical Spacing: Support at base, at equivalent of every floor height (maximum 10' as required by Code) and just below roof line.
2. Screwed or Welded Steel or Copper Piping: Maximum hanger spacing shall be as follows:

	<u>Steel</u>	<u>Copper</u>
1-1/4" and smaller	7' span	6' span
1-1/2" pipe	9' span	6' span
2" pipe	10' span	10' span
2-1/2" & larger	12' span	10' span

3. Polyvinyl Chloride, Polypropylene and Other Plastic Pipe: Maximum hanger spacing and minimum rod diameters as follows:
 - a. Continuous support 1/2" to 4" pipe size Fee & Mason No. 109 channels with Fee & Mason No. 108 hanger. Lay pipe directly into the channel with fittings or couplings placed in spaces between channel sections. Secure piping to the channel at intervals between hangers with a few turns of vinyl electrical tape.
 - b. Non-Continuous Support: Maximum 4' spans or shorter if required by manufacturer for temperatures and pipe schedule.
 - c. Arrange supports to allow free movement, but restrict upward movement of lateral runs so as not to create reverse grade on drainage pipe. Use double bolt clamp or band hanger with restraint (Tolco fig. 25).
4. Install additional hangers or supports at concentrated loads such as pumps, valves, etc. to maintain alignment and prevent sagging.

5. Support Rod: Hanger support rods sized as follows:

<u>Pipe and Tube Size</u>		<u>Rod Size</u>	
<u>Inches</u>	<u>mm</u>	<u>Inches</u>	<u>mm</u>
1/2" to 4"	12.7 to 101.6	3/8"	9.5
5" to 8"	127.0 to 203.2	1/2"	12.7
10" to 12"	254.0 to 304.8	5/8"	15.9

- D. Adjust hangers and supports to bring piping to proper levels and elevations.
- E. Provide all necessary structural attachments such as anchors, beam clamps, hanger flanges and brackets in accordance with MSS SP-69. Attachments to beams wherever possible. Supports suspended from other piping, equipment, metal decking, etc., are not acceptable.
- F. Horizontal banks of piping may be supported on common steel channel member spaced not more than the shortest allowable span required on the individual pipe. Maintain piping at its relative lateral position using clamps or clips. Allow lines subject to thermal expansion to roll axially or slide. Size channel struts for piping weights.
- G. Installation of drilled-in concrete anchors shall comply with the manufacturer's instructions for working load, depth of embedment, and spacing between anchors and from the edge of the slab. Use only wedge-style anchors.
- H. Seismic Restraints: Install restraints where recommended in SMACNA "Seismic Restraint Manual" and as required by code. Show analysis of supporting structure, anchorages, and restraints in accordance with OSSC Section 1613 and reference ASCE standard. Seismic restraint system components shall be approved by the California Office of Statewide Health Planning and Development (OSHDP). Acceptable Manufacturers: Amber/Booth, Mason Industries, Tolco, or approved.

3.9 HVAC SYSTEM IDENTIFICATION

- A. Piping System: Indicate each pipe system by its generic name (abbreviated) as shown/scheduled/specified. Extend the existing or match Owner's color code and/or identification system. Comply with ANSI A13.1 for marker locations, letter sizes, and colors. Include arrows to show direction of flow and "Electric Traced" signs to identify heat cable wrapped piping. Locate pipe labels in accessible areas as follows:
1. Near each valve, meter, gauge, or control device.
 2. Near equipment such as pumps, heat exchangers, water heaters, etc.
 3. At piping branch connections.
 4. At penetrations (each side) of walls, ceilings, and floors.
 5. At access panels and doors.
 6. At 25 foot maximum intervals. Provide a minimum of one label above each room where lift-out ceiling is installed. Reduce intervals in congested areas such as mechanical rooms.

- B. Valve Identification: Tag all valves with brass disc and chain. Prepare valve charts indicating valve number, size, location, function and normal position. Use no duplicate numbers in Plumbing and Heating systems and, where possible, extend the existing identification system. Mount glazed frames containing one set of valve charts in the building mechanical room.
- C. Duct identification: Indicate each duct system by its generic name (abbreviated) Provide duct labels at major pieces of equipment, on each side of penetrations (walls, floors) and at major duct branches in locations where the ductwork is accessible and located in unfinished spaces.
- D. Equipment: Provide engraved plastic-laminate signs at locations of major equipment such as heat exchangers, pumps, etc. Identify equipment in field same as on drawings. Permanently mount in an appropriate and effective location.
- E. Operation Tags: Where needed for proper and adequate information on operation and maintenance of mechanical systems, provide tags of plasticized card stock, either pre-printed or hand printed to convey the message; example: "DO NOT CLOSE THIS VALVE EXCEPT WHEN THE PUMP IS OFF."

3.10 EQUIPMENT CONNECTIONS

- A. Provide complete connections for all items of equipment requiring such connections, including incidental piping, fittings, trim and labor necessary for a finished working installation. Provide a complete condensate drainage system piped to an approved receptor for all equipment with evaporator coils.
- B. Verify the rough-in and finish requirements for all equipment provided under other Divisions of the work and requiring HVAC piping or duct connections with equipment supplier and installer prior to rough-in.

3.11 PROTECTION

- A. Protect all work and materials against loss or damage. Close all pipe openings with caps or plugs. At final completion, thoroughly clean and deliver all work and equipment in an unblemished new condition. Keep all motors and bearings in watertight and dustproof covers during entire course of installation.
- B. Where concealed pipe or tube other than schedule 40 steel passes through framing members or is attached to framing members within 2 inches of the edge or face of the member, install 16 gauge nail plates to prevent pipe damage due to nails, screws, etc. of other trades.
- C. Protect floors, walls, framing and sheathing where pipe cutting and threading operations are conducted with plastic sheeting under plywood sheets. Extend plastic sheeting beyond the plywood. Clean-up metal cuttings, oil, etc., daily or as necessary to prevent

debris from being tracked beyond the protected area. Damages, as determined by the Architect, due to the pipe cutting/threading operation shall be repaired by the responsible trade.

3.12 CUTTING AND PATCHING

- A. General: Comply with the requirements of Division 1 for the cutting and patching of other work to accommodate the installation of mechanical work. Do all necessary cutting and patching of existing building and yard surfaces required for completion of the mechanical work. Patch to match finish and color of adjacent surfaces for remodels. Coordinate work in remodel and new areas to avoid cutting of new finished surfaces.
- B. Precautions:
 - 1. In the event insulated piping or equipment and/or sprayed or trowelled-on fireproofing, sprayed acoustical material, and similar materials are uncovered during the cutting, patching or demolition operation, notify the Architect immediately to investigate the possibility that it is asbestos-laden material. Do not damage or attempt to remove any material suspected of containing asbestos.
 - 2. Do not proceed with the Work in such areas until so instructed by the Architect.

3.13 PIPE PENETRATION FIRE STOPPING

- A. Install as recommended by manufacturer and in accordance with the product's UL listing. Below are the minimum installation requirements.
 - 1. Install specified penetrating item(s) with required annular spacing in proper size wall or floor opening. Support penetrating item(s) adequately on both sides of construction.
 - 2. Clean all opening and penetrating item surfaces in penetration area to remove loose debris, dirt, oil, wax, grease, old caulking, etc.
 - 3. If needed or required for gypsum or concrete block walls, install specified galvanized steel wire mesh or sleeve recessed and centered inside wall around penetrating item(s) so that it is snug against perimeter of opening.
 - 4. When required, install specified type and depth of backing material in annular space, recessed to required fill depth of fire stopping caulking.
 - 5. Gun, trowel, and/or pump fire stopping sealant to specified depth in annular space around penetrating item(s). Trowel sealant surfaces flush with wall or floor surfaces to a smooth, defect-free finish. Where required, apply specified size caulking bead around penetrating item(s) at zero annular contact areas and tool smooth.

3.14 MECHANICAL PAINTING

- A. Minimum Requirements: Comply with minimum requirements of Division 9, Painting. All mechanical equipment, piping, insulation, etc., exposed in finished areas, storage rooms and other locations except mechanical equipment rooms will be painted under

Section 09 9000.

- B. Painting Materials: Materials shall comply with Section 09 90 00, Painting and shall be compatible with the material to be painted.
- C. Uninsulated Piping: Paint black or galvanized uninsulated piping located buried in ground, in concrete or masonry one (1) coat acid-resisting black paint. Paint black or galvanized uninsulated piping in moist equipment rooms, crawl spaces without vapor barriers, or exposed to weather one (1) coat black asphaltum varnish.
- D. Iron Work: Paint hangers, rods, anchors, guides, threads of galvanized pipe, bases, supports, uncoated sheet metal and other iron work without factory finish, exposed to weather, located in moist concealed spaces and moist equipment rooms, one coat acid-resisting black paint. Apply one (1) coat Dixon's Aluminum Graphite No. 209 paint over the (1) coat primer as recommended by paint manufacturer to all hot metal surfaces.
- E. Piping in Mechanical Room: All insulated and uninsulated piping exposed in mechanical equipment rooms shall be painted. Painting is not required for cast iron, plastic, or glass waste piping, or for stainless steel piping, PEX tubing and soft copper tubing. Contractor shall submit proposed colors for approval. In lieu of painting, insulated piping may be covered with colored PVC insulation jacketing as specified in Section 23 07 00, HVAC Insulation.
- F. Insulated Piping and Other Insulated Surfaces: Paint insulated piping in half-round, split tile, or other inaccessible locations, one (1) coat asphalt emulsion.

3.15 HVAC WORK CLOSEOUT

- A. General: Refer to the Division 1 sections for general closeout requirements. Calibrate all equipment requiring same. Complete each system as shown or specified herein and place in operation except where only roughing-in or partial systems are called for. Each system shall be tested and left in proper operation free of leaks, obstructions, or contamination.
- B. Record Drawings: Submit record set of drawings as previously specified in this Section.
- C. Closeout Equipment/Systems Operations: Sequence operations properly so that work of project will not be damaged or endangered. Coordinate with seasonal requirements. Operate each item of equipment and each system in a test run of appropriate duration with the Architect present, and with the Owner's operating personnel present, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance. Clean and lubricate each system and replace dirty filters, excessively worn parts and similar expendable items of the work.
- D. Operating Instructions: Conduct a walk-through instruction seminar for the Owner's personnel who are to be involved in the continued operation and maintenance of the HVAC equipment and systems. Provide written instructions outlining and explaining the

identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar features of the systems.

END OF SECTION

SECTION 23 0550 – MECHANICAL DEMOLITION**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

1.2 SUMMARY

- A. Section Includes:
 - 1. Revise subparagraphs below to suit Project.
 - 2. Demolition and removal of selected components of mechanical systems.
 - 3. Cutting and patching of building assemblies as required for mechanical demolition. Temporary partitions.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner where indicated on drawings.
- C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- E. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- F. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.5 INFORMATION SUBMITTALS

- A. Coordinate "Qualification Data" Paragraph below with qualification requirements in Section 01 4000 "Quality Requirements" and as may be supplemented in "Quality

Assurance" Article.

- B. Retain "Proposed Protection Measures" Paragraph below if selective demolition operations occur adjacent to occupied spaces and an informational submittal is required.
- C. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
- D. "Schedule of Selective Demolition Activities" Paragraph below may be used to track Contractor's progress; it may also be used to determine that selective demolition will not interfere with Owner's operations.
- E. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building manager's and other tenants' on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- F. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.
- G. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered. Also see mechanical specifications for further requirements.

1.6 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.7 FIELD CONDITIONS

- A. Retain, revise, or delete this article to suit Project. Insert other limitations if necessary, such as when adjacent floors will be occupied.
- B. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

- C. Review first paragraph below and revise if necessary. In subparagraph, include list of items that will be removed by Owner.
 - D. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
 - E. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
 - F. Retain one of two "Hazardous Materials" paragraphs below, or remove all references to hazardous materials. Insert scope of article to include asbestos, PCBs, and other materials if required. Coordinate statements with the General and Supplementary Conditions. See "Hazardous Materials" Article in the Evaluations.
 - G. Hazardous Materials: Hazardous materials may be encountered in the Work.
 - 1. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.
 - H. Retain "Historic Areas" Paragraph below if historic removal or dismantling is required.
 - I. Movement of materials: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within spaces, areas, rooms, and openings, including temporary protection, by 6 inches or more.
 - J. Storage or sale of removed items or materials on-site is not permitted.
 - K. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.
- 1.8 WARRANTY
- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties. Notify warrantor before proceeding. Existing warranties may include the following:
 - 1. Roofing systems.
 - B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

1.2 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated on existing drawings.
- C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Engineer and Owner.
- E. Survey of Existing Conditions: Record existing conditions by use of measurements, preconstruction photographs and templates.
 - 1. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. See Mechanical, Plumbing, and Electrical specifications for utility services and mechanical/electrical system requirements.
- B. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 - 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices

- 5. during flame-cutting operations.
 - 6. Maintain adequate ventilation when using cutting torches.
 - 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 - 8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 9. Dispose of demolished items and materials promptly.
- B. Reuse of Building Elements: Do not demolish building elements beyond what is indicated on Drawings without Engineer's approval.

3.5 DISPOSAL OF DEMOLISHED MATERIALS

- A. First option in "Nonshell Elements" Subparagraph below is requirement for LEED-CI Credit MR 1.2; second option is for Credit MR 1.3.
- B. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
- 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- C. Burning: Do not burn demolished materials.
- D. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.6 CUTTING AND PATCHING

- A. Temporary Support: Provide temporary support of work to be cut.
- B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching as required.
- D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such

services/systems before cutting to minimize and prevent interruption to occupied areas.

3.7 TEMPORARY PARTITIONS

- A. Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner and tenants from fumes and noise.
 - 1. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each side. Cover finished floors with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover finished floors with fire-retardant-treated plywood.
 - 2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 - 3. Protect air-handling equipment.
 - 4. Provide walk-off mats at each entrance through temporary partition.

3.8 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION

SECTION 23 0590 – TESTING, ADJUSTING AND BALANCING**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. **Work Included:** After completion of the work of installation, test and regulate all components of the new heating, air conditioning and ventilating systems to verify air volumes and heating-cooling flow rates indicated on the Drawings.
- B. **Related Work:** The requirements of Section 23 0500, Common HVAC Materials and Methods, also apply to this section.
- C. **Balancing Organization:**
 - 1. **Balancing of the Heating and Air Conditioning Systems:** Performed by a firm providing this service established in the State of Oregon.
 - 2. **Balancing Organization:** Subject to compliance with these specifications, the following organizations may submit qualifications for approval. Accurate Balancing Agency, Air Balancing Specialty, Air Introduction & Regulation, Northwest Engineering Services, Neudorfer Engineers, Pacific Coast Air Balancing, or approved.
 - 3. Provide all necessary personnel, equipment, and services.

1.2 QUALITY ASSURANCE

- A. **Balancing of the Heating and Air Conditioning Systems:** Agency shall be a current member of NEBB or AABC specializing in the adjusting and balancing of systems specified with a minimum of 10 years documented experience.
- B. Testing, adjusting, and balancing shall be performed under direct field supervision of a Certified NEBB Supervisor or a Certified AABC Supervisor.

1.3 SUBMITTALS

- A. **Balancing Data:** Include the following minimum information in the Operation and Maintenance Data, as specified in Section 23 0500. Airflow measurements shall be corrected for temperature and elevation.
 - 1. Names or initials of personnel performing the balancing.
 - 2. Dates balancing was performed.
 - 3. List of balancing instruments utilized.
 - 4. Weather conditions at the time of the test.
 - 5. Mechanical system descriptions.
 - 6. All motor rated voltages, amps, starter and overload protective device sizes.
 - 7. All motor operating data.

8. Fan cfm, rpm, operating static pressures, driven and motor sheave data, and all drive changes necessitated to obtain design capacities. List actual minimum outside air volumes measured for each system.
9. Type and size of filters installed in each filter bank.
10. All supply, return and exhaust air outlet cfm readings.
11. Terminal unit cfm and static pressures on full cooling and heating, and final settings.
12. Coil steam pressure and entering and leaving air temperatures.
13. Coil chilled water supply and return temperatures and entering and leaving air temperatures.
14. Coil heating water entering and leaving temperatures and entering and leaving air temperatures.
15. Condensing water supply and return temperatures.
16. Pump gpm, rpm, pressure, horsepower and service.
17. Electric heating elements voltage and amperage for each stage of heat.
18. Power Exhaust fan settings – cfm or % of supply airflow and power exhaust fan start point (% of outside air damper position).
19. CO2 controller set points – minimum CO2 setpoint (ppm), maximum CO2 setpoint (ppm)(setting for min OSA at full occupancy).
20. OSA intake damper settings at min occupancy and max occupancy (cfm or damper %)

1.4 DETAILED REQUIREMENTS

A. Adjusting and Balancing:

1. Prior to beginning the balancing work, obtain from the Architect the latest version of the mechanical drawings including addenda, revisions, change orders, etc.
2. Adjust and balance all portions of the mechanical systems to produce indicated results within limits of minus 5 or plus 10 percent or as subsequently directed by the Architect.
3. Balancing data may be spot checked with instruments similar to that used by the balancing firm.
4. If, in the judgment of the Architect, the discrepancies warrant additional adjustment, readjust and rebalance the systems at no additional project cost.
5. Adjust diffuser throws as shown on the drawings (shown as directional arrows)
6. Where power exhaust fans are specified, set power exhaust fans to operate as shown on drawings and set power exhaust fan cfm percentage as shown on drawing.
7. Set outside air intake dampers to modulate between min occupancy setting and max occupancy setting (as specified on drawings) as CO2 levels rise from minimum set point to maximum set point (as specified on drawings).

END OF SECTION

SECTION 23 0700 – HVAC INSULATION**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. The requirements of this section apply to the insulation of mechanical equipment specified elsewhere in these specifications.
- B. Related Work: The requirements of Section 23 0500, Common HVAC Materials and Methods, also apply to this section.

1.2 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. Preference will be given to those who have successfully completed a manufacturer's installation training program, such as the 'Armacell Qualified Installer Program' (AQIP) or similar.
- B. Inspection: A certified mechanical insulation shall be performed by inspectors who maintain current certification, by the National Insulation Association or other certified mechanical association, throughout the project to inspect and verify the materials and the total insulation system has been installed correctly in accordance with the specifications and material manufacturer's instructions.
- C. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products listed and labeled in accordance with UL 723 or in accordance with ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- D. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
 - 1. Piping Mockups:
 - a. One 10-foot (3-m) section of NPS 2 (DN 50) straight pipe.
 - b. One each of a 90-degree threaded, welded, and flanged elbow.
 - c. One each of a threaded, welded, and flanged tee fitting.

- d. One NPS 2 (DN 50) or smaller valve, and one NPS 2-1/2 (DN 65) or larger valve.
 - e. Four support hangers including hanger shield and insert.
 - f. One threaded strainer and one flanged strainer with removable portion of insulation.
 - g. One threaded reducer and one welded reducer.
 - h. One pressure temperature tap.
 - i. One mechanical coupling.
2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 4. Obtain Architect's approval of mockups before starting insulation application.
 5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 7. Demolish and remove mockups when directed.
 8. Insulation Thickness and Thermal Performance: Comply with the provisions of the State of Oregon Energy Efficiency Specialty Code (OSEEC).
 - a. State of Oregon Title 24 Energy Conservation Standards.
 - b. State of Oregon Energy Regulations.
- E. Composite (Insulation, Jacket or Facing and Adhesives) Fire and Smoke Hazard Ratings: Not to exceed a flame spread of 25 or smoke development of 50 and containing less than 0.1% by weight deca-PDE fire retardant.
- F. Component Ratings of Accessories (Adhesives, Mastics, Cements, Tapes, Finishing Cloth for Fittings): Same as "B" requirements above and permanently treated. No water soluble treatments.
- 1.3 PRODUCT DELIVERY, STORAGE AND HANDLING
- A. General: In addition to the requirements specified in Section 23 0500, the following apply:
1. Deliver insulation, coverings, cements, adhesives and coatings to the site in factory-fabricated containers with the manufacturer's stamp or label affixed showing fire hazard ratings of the products. Store insulation in original wrappings and protect from weather and construction traffic.
 2. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged insulation. Remove such insulation from project site.
- 1.4 SUBMITTALS
- A. Submit catalog data and performance characteristics for each product specified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Insulating Manufacturers: Johns Manville, Knauf, Armacell, Owens-Corning, Pittsburgh Corning, Pabco, Imcoa, Nomaco, or Certain Teed. Johns Manville products are listed unless indicated otherwise.
- B. Adhesive Manufacturers: Foster, 3M, Insul-Coustic, Borden, Kingco or Armacell.

2.2 PIPING INSULATION

- A. Interior and Exterior Piping Systems 50 to 850 Deg. F, ASTM C 547: Glass fiber preformed pipe insulation with a minimum K-value of 0.23 at 75 Deg. F, a minimum density of 3.5 pounds per cubic foot within all-service vapor barrier jacket containing less than 0.1% by weight deca-PDE fire retardant, vinyl or pre-sized finish and pressure sensitive seal.
- B. Exterior Installations: Same as for interior installations except 0.016" aluminum finish jacket [or, in coastal environments, 0.01" stainless steel].
- C. Interior Piping Systems 32 to 50 Deg. F: Glass fiber preformed pipe insulation with a minimum K-value of 0.23 at 75 deg. F, a minimum density of 3.5 pounds per cubic foot. Polymer vapor barrier jacket containing less than 0.1% by weight deca-PDE fire retardant and with pressure sensitive seal and wicking system to remove condensation from pipe surface. Owens Corning "VaporWick."
- D. Pipe Temperatures Minus 30 to 180 Deg. F: Flexible, preformed, pre-slit, self-sealing elastomeric pipe insulation, thermal conductivity of 0.27 BTU/hr. sq. ft./in. at 75 deg. F and vapor transmission rating of 0.2 perms/inch. Armacell AP ArmaFlex or, in concealed locations, Imcoa or Nomaco also approved.
- E. Insulation Materials will be listed and labeled per UL723, in Plenum Spaces as required by code.
- F. Flexible Elastomeric: Closed-Cell, or expanded-rubber materials. Comply with ASTM C534, (Type I for tubular materials OR Type II for sheet materials), and Listed and Labeled per UL 723 at 25/50, in Plenum Spaces as required by code.
- G. Pipe Temperatures up to 1200 Deg. F: High temperature molded calcium silicate insulation with aluminum metal jacket. Furnish with aluminum snap straps. Apply in thickness required for a maximum surface temperature of 120 deg. F at 80 deg. F ambient and for the flow media temperatures. Johns Manville Thermo-12/Gold.

2.3 DUCT INSULATION

- A. Insulation Materials will be listed and labeled per UL723, in Plenum Spaces as required by code.

- B. Interior Above Grade Ductwork: Glass fiber formaldehyde-free blanket with "FSK" facing containing less than 0.1% by weight deca-PDE fire retardant, k value = 0.31 at 75 deg. F, 0.2 perms, and UL 25/50 surface burning rating. Johns Manville "Microlite."
- C. Below Grade Ductwork: Insulate with foamed-in-place urethane insulation.
- D. Exterior Above Grade Ductwork: Glass fiber board with "FSK" facing containing less than 0.1% by weight deca-PDE fire retardant, 3 pound density, k value of 0.23 at 75 deg. F and 0.2 perms. Install with 0.016" aluminum jacket. [0.01" stainless steel jacket.] Johns Manville 800 Series Spin-Glas.

2.4 EQUIPMENT INSULATION

- A. Equipment Temperatures Below 70 Deg. F: Flexible, closed cell, elastomeric sheet insulation of 5.5 #/cubic feet density and 0.27 thermal conductivity at 75 deg. F. Armacell "APArmaflex."
- B. Equipment Temperatures From 70 to 450 Deg. F: Glass fiber 3 pound density insulation with a 0.23 thermal conductivity at 75 deg. F. Johns Manville "814 Spin-Glas" with "FSK" jacket containing less than 0.1% by weight deca-PDE fire retardant or finished as recommended by manufacturer.
- C. Equipment Temperatures From 350 to 1200 Deg. F: Molded high temperature calcium silicate minimum 12.5 pound density and 0.4 thermal conductivity at 200 deg. F mean temperature. Glass cloth finish, Claremont Diplag or finished as recommended by insulation manufacturer.
- D. Exterior Tanks and Equipment Insulation Covering: Same as interior insulation with weatherproof metal or finished as recommended by insulation manufacturer.

2.5 INSULATION ACCESSORIES

- A. Insulation Compounds and Materials: Provide rivets, staples, bands, adhesives, cements, coatings, sealers, welded studs, etc., as recommended by the manufacturers for the insulation and conditions specified except staples not permitted on chilled water lines.
- B. Interior Tanks and Equipment Insulation Covering: Finished metal jacket or as recommended by the manufacturer for insulation material specified.
- C. PVC Protective Jacketing and Valve and Pipe Fitting Covers: Johns Manville Zeston 2000, Proto LoSmoke, Speedline Smoke Safe, or Ceel-Co Ceel-Tite 100 Series with precut fitting fiberglass insulation or approved.
- D. Jacket Lap Sealing Adhesives: Foster Drion 85-75 contact cement or approved substitute.

- E. Saddles and Shields: Install to prevent crushing of insulation at support points.
1. Protection Saddles: MSS Type 39. Armacell Insuguard Multi
 2. Protection Shields: MSS Type 40. Armacell ArmaFix Ecolight
 3. Preinsulated Pipe Supports: Calcium silicate load bearing metal jacketed inserts. Pipe Shields Inc. or accepted substitute.
 - a. Pipe supported on rods - Models A1000, A2000, A3000, A4000.
 - b. Pipe supported on flat surfaces - Models A1000, A2000, A3000, A4000.
 - c. Pipe supported on pipe rolls - Models A3000, A4000, A5000.
 - d. Vertical riser clamp – Models E1000, E1100, E1200.
- F. Removable/Reusable Insulation Covers:
1. 200 to 600 Deg. F Insulation Filler: Install 2-1/4# - 4#/cu. ft. glass fiber, 6# - 8#/cu. ft. mineral wool or glass fiber/type E felted (9#/cu. ft.) flexible blankets and pads for large, irregular shaped equipment such as pump casings, bolting flanges, etc. For small common shapes such as valves, elbows, flanges, etc., install preformed flexible glass fiber pipe wrap, preformed glass fiber pipe covering or glass fiber/type E felted (9#/cu. ft.) insulation.
 2. 600 - 1000 Deg. F Insulation Filler: Install 4# - 8#/cu. ft. refractory fiber felted, 8# - 10#/cu. ft. mineral wool or glass fiber/type E felted (9#/cu. ft.) flexible blankets and pads. Install mineral wool pipe wrap, glass fiber/type E felted (9#/cu. ft.), laminated refractory fiber (4# - 6#/cu. ft.) with flexible glass fiber wrap or refractory (ceramic) fiber (6#/cu. ft.) preformed insulation.
 3. Over 1000 Deg. F Insulation Filler: Install refractory (ceramic) fiber (6# - 8#/cu. ft.) blanket or pad insulation or 6#/cu. ft. preformed insulation.
 4. Encasement, 200 to 600 Deg. F: Glass fiber cloth plain or silicon coated on both sides, knitted stainless steel mesh, glass fiber cloth laminate with aluminum, or stainless steel foil or hex wire mesh.
 5. Encasement, 600 to 1000 Deg. F: Glass fiber cloth with stainless or monel wire insertion, knitted stainless steel mesh, ceramic cloth, or glass fiber cloth laminated with stainless steel foil.
 6. Encasement, Over 1000 Deg. F: Refractory cloth with nickel or inconel wire insertion, knitted inconel mesh or ceramic cloth with nickel wire insertion.
 7. Cold Encasement: Glass fiber cloth silicon coated both sides, knitted stainless steel mesh, glass fiber cloth laminate with aluminum or stainless steel foil or glass fiber cloth with nickel wire insertion, silicon coated both sides.
 8. Stitching, 200 to 600 Deg. F: Glass fiber thread/PVC coated, staples - galvanized or stainless steel, galvanized or stainless steel hog rings, 0.010" - 0.15" dia/dead soft stainless steel wire.
 9. Stitching, 600 Deg. F: Same as 200 to 600 Deg. F above except no galvanized staples or rings and PVC coated thread to 850 deg. F.
 10. Attachments and Securements:
 - a. Quilting: Stainless 2-hole washers, both sides with twisted 0.035" - 0.051" wire loops, 12 ga. stainless spindle/washer/ speed clip assembly or stainless 0.035" - 0.051" wire loops.

- b. Lacing and Hooks: Stainless 2-hole 12 gage bent wire lacing hooks, stainless 2-hole dished washer assembly with twisted 0.035" - 0.051" wire loops, 12 gage stainless spindle washer with built-in hook and speed clip or stainless 1-hole dished and flat washer riveted through the cloth.

PART 3 - EXECUTION

3.1 PIPING INSULATION

- A. General: Do not insulate underground piping except at joints and fittings on preinsulated piping unless indicated otherwise.
- B. Steam Piping: Insulate above ground steam piping with glass fiber pipe covering; thickness as follows:

1. Under 15 psig:

<u>Size</u>	<u>Thickness</u>
1-1/2" or smaller	1-1/2"
2" or larger	3"

2. Above 15 psig:

<u>Size</u>	<u>Thickness</u>
1-1/2" or smaller	2"
2" thru 4"	3"
5" or larger	3-1/2"

3. Wire insulation in place with 16 gauge stainless steel wire on 12" centers in half-round, split tile or other underground conduit.

- C. Condensate Return: Insulate same as steam supply.

- D. Heating Water Piping: Insulate with glass fiber pipe covering:

<u>Size</u>	<u>Thickness</u>
1/2" to 1-1/2"	1-1/2"
2" to 3"	2"
4" and larger	2-1/2"

- E. Chilled Water Piping: Insulate with glass fiber pipe covering or flexible, closed-cell elastomeric pipe insulation: AP Armaflex, Adhesive shall be Armaflex 520, 520 Black or 520 BLV Adhesive. The insulation must conform to ASTM C534 Grade 1, Type I.

<u>Size</u>	<u>Thickness</u>
1-1/2" and smaller	1-1/2"
2" and larger	1-1/2"

1. Fittings: PVC fitting covers with vapor-barrier and vapor wicking pipe wrap.
2. At Hangers: Preinsulated pipe supports as specified in Section 23 0500.

- F. Runout piping not exceeding 4 feet in length and 1" diameter between the control valve and the HVAC coil connections shall be insulated with minimum 1/2" thick glass fiber pipe covering.
- G. Refrigerant Piping Insulation: Insulate suction piping with minimum 1" thick flexible, closed-cell elastomeric pipe insulation:
 - 1. AP Armaflex or of thickness necessary to prevent condensation at 85 deg. F and 70% RH. Where possible, slip insulation over the piping as it is installed. Seal all joint and seams.
- H. Pipe Fittings:
 - 1. Insulate and finish all fittings including valve bodies, bonnets, unions, flanges and expansion joints with precut fiberglass insulation and preformed PVC covers sealed to adjacent insulation jacket for continuous vapor barrier covering over all fittings.
 - 2. Use 1/2" thick Armaflex or Aerotube foamed plastic at flexible pipe connections on chilled and/or cold water lines. No insulation on other flexible pipe connections.
 - 3. Provide removable/reusable insulation covers on 4" and larger valves, unions, flanges, pump casings, strainers and similar fittings or equipment requiring periodic service.
- I. Protective Covering: Install continuous protective PVC or metal covering on all piping and fittings in mechanical rooms, accessible tunnels, attic spaces, accessible ceilings, etc., where insulation may be subject to damage. Install with rivets or cement seams and joints.
- J. Insulated Piping Supports: Where insulated piping with continuous vapor barrier or where exposed to view in finished areas is specified, install hard maple wood insulation shields, insulation inserts, or steel pipe covering protection shields at each hanger.
- K. Piping Insulation Lap Seams and Butt Joints: Install insulation jacket in accordance with manufacturer's recommendation. Where jacket joint and lap seams have not adhered, remove affected section of insulation and reinstall or apply lap sealing adhesive in accordance with manufacturer's instructions.

3.2 DUCTWORK INSULATION

- A. Ductwork: Insulate the following:
 - 1. All supply ductwork, with cooling.
 - 2. All supply and return ductwork in systems routed in unconditioned spaces or exposed to the outside conditions.
 - 3. All outside air intake ducts.
 - 4. All ductwork required to be insulated by code.

- B. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Grade 1, Type II for sheet materials. UL Classified per UL 723 at 25/50 listed and labeled in accordance with UL 723 or in accordance with ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Insulation Thickness: Select board and blanket insulation of thickness required to provide the following installed R-value.
1. All heating or cooling system supply and return ducts located on the exterior of the insulated building envelope, including ventilated attics, and all outside air intake ducts, R-8.
 2. All heating and cooling system supply and return ducts located in unconditioned spaces within the building insulation envelope, R-5.
 3. All heating and cooling system supply ducts located in conditioned spaces and where exposed in unfinished spaces or concealed from view in finished spaces, R-3.3. Exposed ductwork in finished spaces shall not be externally insulated.
 4. Ducts located within or below concrete slabs on grade, R-4.
- D. Fittings: Install with wire, straps, and duct adhesive as required. To prevent sagging on all rectangular or square ducts over 24" wide, install Gramweld or equal welding pins on the bottom. Maximum spacing 18" on center in both directions.
- E. Installation: Applied with butt joints, all seams sealed with vapor seal mastic or taped with 2" wide vapor-proof, pressure-sensitive tape. Seal all penetrations with vapor barrier adhesive.
- F. Internally Lined Ductwork: Where internally lined ductwork is indicated on the Drawings and/or specified, no exterior insulation is required. Select duct lining to provide the required R-value. Carefully lap the ends of the exterior insulation a minimum of 6" past the interior insulation unless otherwise shown. Seal the end of vapor barrier jacket to the duct with mastic where the vapor barrier is required. Duct lining is specified in Section 23 3000.

3.3 EQUIPMENT ROOM ITEMS

- A. Items To Be Insulated: All equipment room items except the following:
1. Condensate receivers.
 2. Cushion (expansion) tanks.
 3. Chemical feed tanks
 4. Breechings.
- B. Materials:
1. 1-1/2" calcium silicate blocks applied with wire or bands as required. Finish with 1/2" thick smoothing coat of insulating cement and with glass cloth.

2. For equipment and piping systems operating below 350 deg. F., a 3 pound per cubic foot, 1-1/2" thick spun glass fiber blanket with organic binders and aluminum sheet metal exterior jacket may be substituted for the above insulation.
3. Install tank head finish per manufacturer's recommendations.

C. Manholes, Nameplates, Handholes, Cleanouts, Etc.: Do not insulate over manholes, ASME Code stamps, manufacturer's nameplates, handholes, cleanouts, etc. Provide neatly beveled edges at interruptions of the insulation. When surfaces are to operate below ambient saturation temperatures, provide removable sections of insulation to cover the above with vapor sealed edges. Provide appropriate tagging.

3.4 CENTRIFUGAL CHILLER

- A. Evaporator Section: Insulate with 3/4" thick foam-plastic sheets applied with Johns Manville No. 27 adhesive. Seal all joints and seams for continuous vapor barrier.
- B. Condenser Section: No insulation required.

3.5 BREECHING INSULATION

- A. 1200 Deg. F rated, 1-1/2" thick, calcium silicate block banded or wired and anchored with welded studs and clips and covered with 1/2" insulating cement coat and finished as recommended by insulation manufacturer.

3.6 EXPOSED COOLING TOWER PIPING

- A. Insulated all water piping exposed to outside weather and freezing temperatures with specified thickness of glass fiber pipe covering with weather-proof metal jacket. (Include tower makeup water, condensing water supply and return.) Apply insulation after heat cable is installed.

3.7 EXPANSION JOINTS

- A. Insulation: Insulate expansion joints on heating and/or cooling piping to match thickness of adjacent piping. Build up piping insulation adjacent to the expansion joints sufficiently to allow internal clearance within the insulation for the diameter of the expansion joint. Fasten one end of the expansion joint insulation securely and provide aluminum or sheet metal on the built-up insulation at the other end to permit movement of the insulation without damage.
- B. Finish: Finish as specified for adjacent piping with fireproof covering.

3.8 UNDERFLOOR DUCT SYSTEM

- A. Material: Foamed-in-place urethane by an experienced foam-in-place urethane insulation Contractor.

23 0700 - 10

HVAC INSULATION

END OF SECTION

SECTION 23 1000 – FACILITY FUEL GAS SYSTEMS**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. The requirements of this section apply to the fuel gas distribution systems for the facility.
- B. Related Work: The requirements of Section 23 0500, Common HVAC Materials and Methods, also apply to this section.

1.2 CODES AND STANDARDS

- A. Comply with the provisions of the following referenced codes, standards and specifications:
 - 1. National Fire Protection Association (NFPA)
 - 2. Underwriters Laboratories, Inc. (UL)
 - 3. Factory Mutual (FM)
 - 4. National Fuel Gas Code (NFPA 54)
 - 5. Liquefied Petroleum Gas Code (NFPA 58)
 - 6. International Mechanical Code (IMC) with State and Local Amendments
 - 7. American Society for Testing and Materials (ASTM)
 - 8. International Fire Code (IFC) with State and Local Amendments
 - 9. American Gas Association (AGA)

1.3 SUBMITTALS

- A. Required for all items.

PART 2 - PRODUCTS**2.1 PIPING MATERIALS**

- A. Black Steel Pipe:
 - 1. Applications: Indoors or underground.
 - a. Natural Gas.
 - 2. Pipe: Systems 10" or smaller, operating below 400 psi, schedule 40, standard black steel pipe ASTM A-120 or A-53.
 - 3. Underground Piping: Coated with a minimum of ten mils of factory applied 100% thermosetting epoxy resin.
 - 4. Threaded Fittings: For above ground installations only. Banded class 150 malleable iron fittings, ANSI B16.3 to 150 psi.
 - 5. Welding Fittings: Standard weight, seamless steel, beveled end fittings, ANSI B16.9.

6. Flanged Fittings: For above ground installations only.
 - a. Class 150 steel welding neck flanges, ANSI B16.9 to 150 psi.
 - b. Facing and Gasketing: Selected for service pressures and temperatures. Raised face for steel flanges.

B. Galvanized Steel Pipe:

1. Applications: Above ground only.
 - a. Natural gas, outdoors.
2. Pipe: Schedule 40, standard galvanized steel pipe, ASTM A-53 or A-106.
3. Fittings: Banded class 150 galvanized malleable iron threaded fittings, ANSI B16.3.

C. Flexible Fuel Gas Piping (CSST):

1. Application: 5 psi or less:
 - a. Natural gas
 - b. LPG (Propane gas)
2. Pipe: Corrugated 300 series stainless steel tubing with yellow polyethylene jacketing.
3. Fittings: Fittings shall be yellow brass and provide a self-flaring connection to the tubing. Systems incorporating gaskets or o-rings are not acceptable.
4. Underground Installations: CSST pre-sleeved with heavy wall internally ribbed polyethylene secondary venting conduit with end seals and vent connection fittings.
5. Approvals: System shall be listed by an approved independent laboratory and approved for use by the local code officials. TracPipe, Gastite, or approved.

2.2 PIPING ACCESSORIES

A. Fuel Gas Valves: UL listed or AGA approved valves.

1. 10 psig or Less:
 - a. Ball: NIBCO bronze body T/S 585-70-UL, brass body FP-600.

B. Strainers: Threaded bronze or iron body for 175 working pressure, Y pattern with 1/32" stainless steel perforated screen.

C. Gas Pressure Regulators: Size based on pressures indicated on the drawings and for 1.5 times connected load. Style and model as approved by Northwest Natural Gas Co. Maxitrol, Rockwell, Fisher, Reliance, or approved substitute.

D. Gas Appliance Connectors: For low pressure gas connection to indoor or outdoor rigidly mounted stationary appliances, AGA approved corrugated stainless steel tubing with zinc plated steel end fittings. Brasscraft or approved substitute.

E. Gas Connection Hose: For low pressure gas connection to moveable appliances

including cooking equipment, flexible hose consisting of inner tube, stainless steel braid, and outer protective jacket with swivel steel threaded end fittings. T & S Brass HG series, or approved substitute.

- F. Gas Meter: Diaphragm style positive displacement meter in primed and painted weather resistant cast aluminum case. Delivery pressure rating, flow, and fuel gas as indicated on the drawings. Maximum allowable operating pressure rating of 2 psi or greater. Temperature compensated style where installed outdoors. ANSI B109.1 compliant. Accuracy of +/- 0.5% over rated flow range. Pointer style cubic foot register with security seals. Provide with meter mounting bar and shutoff valve. American Meter, Equimeter, or approved.
- G. Seismic Gas Shutoff Valve: Self-actuating valve UL certified to ASCE 25-06 and approved by the serving utility and designed for outdoor mounting downstream of the utility regulator. Swing check style valve to close in direction of flow with factory sealed acceleration sensitive trip mechanism with manual reset and visual indicator of valve position. 60 psi pressure rating and NPT threaded or ANSI Class 125 flanged end connections. Pacific Seismic Products or approved substitute.

2.3 EXPANSION JOINTS AND LOOPS

- A. Flexible Expansion/Seismic Loop: Factory fabricated assembly consisting of two elbows and return bend or three elbows, and two lengths of flexible hose to allow free movement in three axis. Return bend or elbow shall include a drain/vent fitting. Hose shall be corrugated metal style with metal overbraid compatible with the piping materials. Connections to match piping system except connection 2" and larger shall be flanged style. Listed for fuel gas use. Metraflex "Metraloop" or Unisource "Uni-loops".

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Locating and Positioning Equipment: Observe all Codes and Regulations and good common practice in locating and installing mechanical equipment and material so that complete installation presents the least possible hazard. Maintain adequate clearances for repair and service to all equipment. Installation of any equipment with less than minimum clearances shall not be accepted.
- B. Anchorage: Anchor and/or brace mechanical equipment and piping to resist displacement due to seismic action.
- C. Gas Pressure Regulators: Install with drip leg at regulator inlet and capped test tees at inlet and outlet piping connections. Vent to exterior in accordance with code requirements except where vent limiting devices are installed.

3.2 PIPE INSTALLATION

- A. General: Install pipe, tube and fittings in accordance with recognized industry practiced for each indicated service without piping failure. Install each run with a minimum of joints and couplings, but with adequate and accessible unions and flanges for disassembly, maintenance and/or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections.
- B. Ferrous Threaded Piping: Thread pipe in accordance with ANSI 82.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave no more than 3 threads exposed.
- C. Flexible Gas Piping (CSST): Comply with manufacturer's recommendations for system installation. Provide striker plates and supports as required. All penetrations of finished walls, including mechanical room walls, shall be accomplished using surface or recessed termination fittings. Where installed underground below a building, vent the conduit to outdoors per Code.
- D. Changes in Direction: Use fittings for all changes in direction. Run lines parallel with building surfaces.
- E. Unions and Flanges: At all equipment to permit dismantling and elsewhere as consistent with good installation practice.
- F. Expansion: Provide loops, swing joints, anchors, runouts and spring pieces to prevent damage to piping or equipment.
- G. Underground Gas Piping: Standard schedule 40 black steel pipe with welding fittings coated with a minimum of ten mils of 100% thermosetting epoxy resin, Scotchkote No. 203 factory applied per resin manufacturer's recommendations. Wrap all joints with 10 mil polyvinyl chloride pipewrap tape to a total thickness of 40 mils. Provide one 15 pound magnesium anode per each 100' of underground pipe, attached to coupling or other fitting with No. 10 copper wire. No underfloor slab natural gas piping except as provided for by code.

3.3 GAS SERVICE

- A. Contact Northwest Natural Gas Co. service as required and pay all costs involved. Run all gas distribution piping and make final connections to all gas using equipment. Install regulators to deliver proper inlet pressures and vent regulators to outside where required.

3.4 CLEANING

- A. General: Clean all dirt and construction dust and debris from all mechanical piping systems and leave in a new condition. Touch up paint where necessary.

- B. Fuel Piping: Blow clear of debris with nitrogen or oil free air.

3.5 TEST

- A. General: Minimum duration of two hours or longer, as directed for all tests. Furnish report of test observation signed by qualified inspector. Make all tests before applying insulation, backfilling, or otherwise concealing piping or connecting fixtures or equipment. Where part of the system must be tested to avoid concealment before the entire system is complete, test that portion separately, same as for entire system.
- B. Natural Gas Piping: One half hour minimum air at 60 psig for 2 psig gas, and 15 minutes at 10 psig for 7" water gauge natural gas or as approved and certified by serving utility.
- C. Storage Tanks: Test tank according to manufacturer's recommendation.

3.6 MECHANICAL PAINTING

- A. Uninsulated Piping: Paint black steel piping in moist equipment rooms, crawl spaces, inside of secondary containment piping, or exposed to weather two (2) coats black rust-inhibiting paint.

END OF SECTION

SECTION 23 2300 – REFRIGERANT PIPING SYSTEM**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. The requirements of this section apply to the refrigerant piping system connecting refrigeration and HVAC equipment specified in other sections of these specifications. Provide pipe, pipe fittings and related items required for complete piping system.
- B. Related Work: The requirements of Section 23 0500, Common HVAC Materials and Methods, also apply to this section.

1.2 QUALITY ASSURANCE

- A. General: ASTM, and ANSI Standards are indicated. In addition, special standards are referenced where neither ASTM nor ANSI Standards are applicable. Comply with federal and local regulations regarding the handling of refrigerant.
- B. Labeling: All piping shall be continuously and legibly labeled on each length as required by codes and standards and including as a minimum, country of origin, manufacturer's identification marking, wall thickness designation, and applicable standards and approvals. Fittings shall be labeled as required by the referenced standard. Tubular fixture traps shall be stamped with manufacturer's mark and material thickness.
- C. Air Conditioning, Heating, and Refrigeration Equipment Rating: Rated in accordance with AHRI certified rating procedures and bear the AHRI label.
- D. Installation Contractor: Manufacturer's authorized installation and start-up agency normally engaged and experienced in air conditioning/refrigeration work and certified in the handling of refrigerant.

1.3 SUBMITTALS

- A. Submit catalog data, construction details, and performance characteristics for each type and size of refrigeration equipment.
- B. Submit operating and maintenance data.

1.4 STORAGE AND HANDLING

- A. Provide factory-applied end caps on each length of pipe and tube. Maintain end caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2 - PRODUCTS**2.1 PIPING MATERIALS****A. Copper Pipe and Tube:**

1. Application: Refrigerant.
2. Pipe: ASTM B88. Type ACR hard temper copper with brazed joints. Cleaned and sealed at the factory.
3. Refrigerant Fittings: ANSI/ASME B31.5 or SAE J 513-F, "Refrigeration Tube Fittings." Where conflicts occur, B31.5 shall govern.

2.2 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

- A. Brazing Materials: Provide brazing filler rod and flux materials as determined by the installer to comply with installation requirements.
- B. Gaskets for Flanged Joints: ANSI B16.21 with pressure and temperature rating required for the service indicated.

2.3 REFRIGERATION SPECIALTIES

- A. General: Provide the following equipment where they are not a part of the factory installed equipment accessories Select equipment for operation with the refrigerant being utilized and for the pressure and temperature conditions indicated. Sporlan, Alco, Henry, Detroit, or as listed for each equipment.
- B. Thermostatic Expansion Valve: Capacity matched for the system, angle or straight through pattern external equalizer, brass body complete with capillary and remote sensing bulb.
- C. Solenoid Valves: For installation in liquid, suction and/or hot gas circuit as indicated. Brass body, replaceable coil of voltage indicated.
- D. Liquid and Moisture Indicators: Moisture and liquid indicator installed after the liquid line filter dryer.
- E. Liquid Line Filter Dryer: Sealed container up to approximately 10 tons of capacity and replaceable desiccant dryer core and strainer on larger capacity systems.
- F. Charging Valves: Quick coupling type connection with removable valve core.
- G. Service Valves: Install liquid, suction and discharge line valves, all suitable for refrigerant used and location in the system, designed so as to be easily packed with pressure on the line and with wing caps that completely enclose valve stem. Install all purge valves, relief valves or other valves required for safe and proper operation of the system and as may be required by State or local codes. Detroit, Alco, Sporlan or

Automatic Products approved substitute.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. General: Install pipe, tube and fittings in accordance with recognized industry practices. Install each run accurately aligned with a minimum of joints and couplings, but with adequate and accessible unions and flanges for disassembly, maintenance and/or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings.
- B. Piping Runs: Route piping close to and parallel with walls, overhead construction, columns and other structural and permanent-enclosure elements of the building. If not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building or equipment and avoid diagonal runs. Wherever possible in finished and occupied spaces, conceal piping from view. Do not encase horizontal runs in solid partitions.
- C. Refrigerant Piping:
 - 1. Use Type "L" hard drawn copper tubing and make all changes in direction with specified fittings.
 - 2. Lay out the refrigerant piping system in a manner to prevent liquid refrigerant from entering the compressor and so that oil will return to the compressor. Slope all horizontal suction lines toward the compressor. Take special care to keep all tubing clean and dry.
 - 3. Install all refrigerant piping straight and free from kinks and restrictions, properly supported to minimize vibration. Provide hangers at 5' spacing for 1/2" lines, 6' spacing for 1" lines and 8' spacing for 1-1/2" and larger lines. Submit complete diagram for approval.
 - 4. Comply with the refrigerant piping installation instructions of the refrigeration equipment manufacturer.

3.2 PIPING JOINTS

- A. General: Provide joints of the type indicated in each piping system, and where piping and joint as manufactured form a system, utilize only that manufacturer's material.
- B. Braze Copper Tube and Fitting Joints: Where indicated, in accordance with ANSI/ASME B31.5. Pass a slow stream of dry nitrogen gas through the tubing at all times while brazing to eliminate formation of copper oxide.
- C. Flanged Joints: Match flanges within piping system and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gasket.

- D. Changes in Direction: Use fittings for all changes in direction. Run lines parallel with building surfaces.
- E. Unions and Flanges: At all equipment to permit dismantling and elsewhere as consistent with good installation practice.
- F. Expansion: Provide loops, swing joints, anchors, runouts and spring pieces to prevent damage to piping or equipment.

3.3 MISCELLANEOUS PIPING EQUIPMENT

- A. Floor, Wall and Ceiling Plates: Chrome-plated pressed steel or brass screw locked split plates on all pipe penetrations in finished spaces.
- B. Filters: Install in a manner to permit access for removal and replacement of filter cartridge.
- C. Sleeves: At all penetrations of concrete or masonry construction. PVC, 24 gauge galvanized steel or Schedule 40 galvanized steel pipe. Fabricate sleeves 1" diameter larger than pipe or insulation. PVC and sheet metal sleeves at non-structural penetrations only.
- D. Sleeve Caulking: Grout insulated pipe with cement mortar or approved waterproof mastic. All caulking or grouting shall extend full depth of sleeve. Install UL sealing caulk, putty and/or system at all penetrations of fire rated walls, floors and ceiling.

3.4 CLEANING

- A. General: Clean all dirt and construction dust and debris from all mechanical piping systems and leave in a new condition. Touch-up paint where necessary.
- B. Refrigeration System Piping: If, for any reason, sanitized and sealed-at-the-mill tubing is not used, clean the tubing as follows:
 - 1. Wipe each tube internally with a dry, lintless cloth followed with a clean lintless cloth saturated with recommended refrigerant.
 - 2. Repeat until the saturated cloth is not discolored by dirt.
 - 3. Wipe with a clean cloth saturated with compressor oil and squeezed dry.
 - 4. Wipe with a dry, lintless cloth.

3.5 TEST

- A. General:
 - 1. Minimum duration of two hours or longer, as directed for all tests. Furnish report of test observation signed by qualified inspector. Make all tests before applying insulation, backfilling, or otherwise concealing piping or connecting fixtures or

- equipment. Where part of the system must be tested to avoid concealment before the entire system is complete, test that portion separately, same as for entire system.
2. Provide all necessary temporary equipment for testing, including pump and gauges. Remove control devices before testing and do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for the indicated pressure and time.
 3. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.
- B. Repair: Repair piping system sections which fail the required piping test by disassembly and re-installation, using new materials to the extent required to overcome leakage. Do not use chemical stop-leak compounds, solder, mastics, or other temporary repair methods.
- C. Refrigerant System:
1. When the refrigerant connections have been completed, close the compressor suction and discharge valves (or receiver outlet valve in the case of condensing unit) and test the balance of the system to near operating pressure with a dry nitrogen.
 2. Carefully test all joints, using soap and water or other sudsing solution. After all joints are tested, discharge the gas and repair all leaks, then repeat the test with a mixture of nitrogen and HCFC-22 / R-410A and a halide torch or an electronic leak detector.
 3. Evacuate the system to remove moisture and non-condensables. Lower the absolute pressure with a vacuum pump to 1000 microns of mercury. Apply external heat as required to vaporize moisture.
 4. Dehydrate each refrigerant circuit by satisfactory use of a vacuum pump before charging with refrigerant. Furnish all necessary refrigerant and oil for complete operating charge of the system. Upon completion of the work of construction, test all refrigeration equipment under normal operating conditions and leave in operating order. Adjust automatic temperature controls.
 5. After the first 24 hours of operation, measure the pressure drop across the suction filter. If the pressure drop exceeds 5 pounds per square inch, replace the cartridge with a new one, retesting and replacing the cartridge and/or adjusting the system as necessary to achieve a pressure drop of less than 5 pounds per square inch in 24 hours.

END OF SECTION

SECTION 23 3000 – AIR DISTRIBUTION**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. Provide Air Distribution Materials as specified herein and as shown on the Drawings.
- B. Material characteristics and size shall be as indicated on the Drawings.
- C. Related Work: The requirements of Section 23 0500, Common HVAC Materials and Methods, also apply to this section.

1.2 QUALITY ASSURANCE

- A. Air Distribution Equipment Rating: In accordance with AMCA certified rating procedures and bearing the AMCA label.

1.3 SUBMITTALS

- A. Submit catalog data, construction details and performance characteristics for all manufactured materials.
- B. Submit operating and maintenance data.

PART 2 - PRODUCTS**2.1 SHEET METAL**

- A. Sheet Metal Materials:
 - 1. General Material Requirements: Comply with the Mechanical Code and SMACNA'S "HVAC Duct Construction. Standards – Metal and Flexible, Third Edition" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
 - 2. All interior ducts shall be constructed with G-60 or better galvanized steel conforming to ASTM A653/A653M and A924/A924M Standards, LFQ, chem treat. Exterior ductwork or duct exposed to high humidity conditions (that is: kitchen exhausts, etc.) shall be G-90 or better galvanized steel, conforming to ASTM A653/A653M and A924/A924M Standards, LFQ, chem. treat.
 - 3. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, and having a No. 2D finish for concealed ducts and No. 2B, No. 2D, No. 3 or No. 4 for exposed surfaces.
 - 4. Tie Rods: Galvanized steel, ¼ inch (6 mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8 inch (10 mm) minimum diameter for lengths longer

than 36 inches (900 mm).

- B. Duct Fabrication requirements: Metal gauges, joints and reinforcement in accordance with Mechanical Code, ASHRAE and SMACNA standards. Ductwork shall be fabricated to the following pressure classifications:
1. Return and exhaust ducts: 1" negative.
 2. Supply ducts from fan discharge to diffuser: 3" positive.
- C. Acoustical Duct and Plenum Lining: Flexible or rigid duct liner composed of resin bonded glass fibers. Greenguard® certified. Maximum thermal conductivity of 0.25 at 75°F. Johns Manville, Owens Corning, Knauf, and Certainteed approved, meeting NFPA 90A requirements for maximum flame spread and smoke developed and containing less than 0.1% by weight deca-PDE fire retardant.
- D. Duct Tapes, Sealants, Adhesives & Gaskets:
1. Two-part sealing system with woven fiber, mineral gypsum impregnated tape and non-flammable adhesive. Hardcast "DT" tape and "FTA-20" adhesive, United "Uni-Cast" system, or accepted substitute.
 2. For joints and seams exposed to the weather in lieu of soldering, United "Uni-Cast" system or approved.
 3. Joint & Seam Sealants (Water Based): Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
 4. Joint & Seam Sealants (Solvent Based): Flexible. Non sag, solvent-release-curing, for use in low temperature applications. Shall be resistant to UV light and shall be UL 723 Listed and meet NFPA requirements for Class 1 ductwork.
 5. Flange Gasket: Butyl rubber or EPDM polymer which complies with UL standard 181 and 723 testing. The gasket shall not contain vegetable oils, fish oils, or any other type of material that will support fungal and/or bacterial growth.
 6. Liner Adhesive: Water based, fire and moisture resistant, used to adhere insulation to metal duct. It shall comply with NFPA 90A and UL 723 requirements.
 7. Duct Liner Sealant: Water based sealant, fire and moisture resistant, used to encapsulate fiberglass duct insulation to eliminate airborne fibers. Must comply with UL requirements.
- E. Optional Duct Joints for Sheet Metal Ducts: Prefabricated slide-on transverse duct connectors will be accepted. Duct constructed using prefabricated connection systems will refer to the manufacturer guidelines for sheet gage, intermediate reinforcement size and spacing, and proper joint reinforcements. "Ductmate System" by Ductmate Industries, Inc., Ward Duct Connectors, Inc., Mez Industries, Elgen, or acceptable substitute. Spiramir self-sealing round duct connector system meeting Class 3 leakage standards with EPDM o-ring seal.
- F. Shower Exhaust: Fabricate exhaust ducts from showers or adjacent areas of copper/aluminum/stainless steel. Metal gauges, joints and reinforcement in accordance

with the Mechanical Code requirements. Solder seams and joints in a water-tight manner. Make fastenings with bronze screws and/or bolts. Electrically insulate copper from dissimilar metals. Pitch duct to drain, grille or register leaving no pockets to collect moisture. Type 304 stainless steel with welded seams and joints approved in lieu of copper.

- G. Exterior and Roof Mounted Ductwork: Construct roof mounted ductwork and other ductwork exposed to outside weather of galvanized steel outer jacket, two gauges heavier than equivalent ductwork with all joints soldered in a weather-proof manner with 2" of internal duct lining. Submit shop drawings.
- H. Exposed to View Spiral Seam Duct: Round and flat oval spiral seam duct shall be manufactured of galvanized steel sheet metal with spiral lock seam. Sizes up to 36" diameter or 36" wide shall be 22 gauge; sizes over 36" shall be 20 gauge. Reinforcement or bracing shall be as detailed on the Drawings. Matching fittings shall be manufactured of galvanized steel with continuous welded seams. Fittings up to 36" diameter or width shall be 20 gauge, fittings larger than 36" shall be 18 gauge.
- I. Concealed Round Duct: Round and flat oval spiral seam duct shall be manufactured of galvanized sheet metal with spiral lock seam. Construction, gauges, and reinforcement in accordance with SMACNA standards. Fittings shall be manufactured of galvanized steel with spot welded or riveted and sealed seams or continuously welded seams. Snap lock longitudinal seam duct shall fully comply with SMACNA standards for duct gauge and seam type for appropriate pressure class. Adjustable elbows are prohibited.
- J. Grease Hood Exhaust Ductwork and Enclosure: SEE CAPTIVE AIR DRAWINGS.
 - 1. Ductwork: Duct and plenums less than four square feet in cross-sectional area shall be constructed of 16 gauge galvanized steel. Ducts greater than four square feet in area shall be constructed of 14 gauge galvanized steel. All welded grease-tight construction. Slope horizontal ducts toward hood. Construct exhaust ducts exposed in the kitchen of type 304, 16 gauge stainless steel with smooth welded joints and No. 4 finish. Provide cleanouts per Code.
 - 2. Rated Enclosure:
 - a. Materials:
 - 1) A lightweight, nominal 1.5" thick, 6pcf, inorganic, non-asbestos, noncombustible, bio-soluble, high temperature, core insulation blanket.
 - 2) Flexible, fully encapsulated duct wrap to provide 2-hour fire resistive enclosure assembly per codes and standards listed in 1.02 of this document.
 - 3) Blanket insulation must maintain a 2012°F (1100°C) operating temperature.
 - 4) Blanket fiber materials must be tested per EU regulatory requirements, Directive 97/69/EC for bio-solubility, and verified by an independent laboratory.
 - 5) Provide rated access doors (for cleanout as required) to maintain 2-hour rating and required clearance.

- 6) Provide firestop sealants, tape, insulation pins, clips, banding and other components as per manufacturer's instructions to ensure installation complies with the complete tested system and corresponding Design Listing(s).
 - b. Performance Requirements:
 - 1) Zero clearance to combustibles across the entire surface of the blanket material, per the internal fire test of ASTM E2336.
 - 2) 2-hour fire resistive enclosure assembly per ASTM E-119.
 - 3) Firestop system, tested per ASTM E-814, 2-hour F and T Ratings.
 - c. Manufacturers: FyreWrap® Elite® or approved equal.
- K. Grease Hood Exhaust Ductwork and Enclosure:
1. Rated Grease Ductwork: AL29-4C inner liner with aluminized steel outer (304 stainless where exposed) rated for commercial Type I hood exhaust at 6" wg. 4" clearance to combustibles, liquid tight construction. Metal Fab series 2G or approved.
- L. Flexible Ductwork-Low Pressure: Insulated low pressure flexible duct, factory fabricated assembly consisting of a zinc-coated spring steel helix seamless inner liner, wrapped with a nominal 1" thick insulation for installation inside the building insulation envelope, and 1-1/2" for installation outside the building insulation envelope, 1 pound/cubic foot density fiberglass insulation. The assembly shall be sheathed in a vapor barrier jacket, factory vapor resistance sealed at both ends of each section. The composite assembly, including insulation and vapor barrier, shall meet the Class 1 requirements of NFPA Bulletin No. 90-A and be labeled by Underwriters Laboratories, Inc., with a flame spread rating of 25 or less and a smoke developed rating of 50 or under. The duct shall have factory sealed double air seal (interior and exterior) to assure an airtight installation. Genflex, ATCO, Wiremold, Thermaflex, Glassflex, Clevepak, Schuller, or accepted substitute.

2.2 ACCESSORIES

- A. Manual Volume Dampers: Construct of material two gauges heavier than duct in which installed; single plate up to 12" wide; multiple over 12" wide. Hem both edges 1/2" and flange sides 1/2". Use Young, Duro-Dyne, Elgen, MAT, Pottoroff or accepted substitute damper accessories. Young numbers are shown.
1. No. 605 bearing set with No. 403 regulator for dampers up to 24" long.
 2. For dampers over 24" long use No. 660 3/8" rod, No. 656 end bearing and No. 403 regulator.
 3. Where damper regulators are not readily accessible, use No. 660 or No. 661 rod extensions and No. 301 and No. 315 concealed damper regulators or MAT cable operated dampers as required.

Location of all volume dampers is not necessarily shown on Drawings; minimum required is one in each supply, return, outside air, or exhaust main, and one in each

branch.

B. Fire Dampers:

1. Provide dampers with rating equal to surrounding construction where penetrations are made through fire-resistant rated construction per applicable codes. Provide access panels of proper fire rating. Size dampers to maintain free area through damper same as unobstructed run of duct or opening.
2. Static Fire Dampers: Constructed and installed in accordance with NFPA No. 90A and UL labeled.
3. Dynamic Fire Dampers: Constructed and approved in accordance with UL Standard 555 for horizontal or vertical installations. Selection of dampers shall not exceed manufacturer's recommended CFM at 4" of static pressure for unducted dampers and 8" of static pressure for ducted dampers.

C. Fire Rated Thermal Blanket and Diffuser Fire Damper: UL listed, non-asbestos ceramic thermal blanket for use on ceiling diffusers with curtain type fire damper to fit diffuser neck indicated.

D. Combination Fire/Smoke Dampers:

1. Constructed and installed in accordance with NFPA No. 90A, UL labeled. Provide dampers with rating equal to surrounding construction where penetrations are made through fire-resistant rated construction per applicable codes.
2. Provide access panels of proper fire rating. Size dampers to maintain free area through damper same as unobstructed run of duct or opening.
3. Each damper shall be classified by UL as a "corridor damper" for installation in tunnel corridors, shall be rated for one hour fire resistance under UL555, and shall have a minimum leakage rating of Class II under UL555S for use in smoke control systems. Each damper shall bear a UL label designating the damper as "corridor damper."
4. In addition to the leakage rating specified herein, the dampers and their actuators shall be classified under UL555S to an elevated temperature of 250 degrees F (121 degrees C). Appropriate electric **motorized** operators shall be installed by the damper manufacturer at time of fabrication and damper/actuator assembly shall be factory cycled 10 times to assure operation. Assembly shall meet all applicable UL555 and UL555S criteria for both damper and actuators. Damper shall be power open-fail close design.
5. Damper manufacturer shall provide factory assembled minimum 20 gage steel sleeve. Damper shall be sealed to the sleeve with a 25/50 flame spread/smoke developed sealant material. Each corridor damper shall be equipped as standard with an electric fusible link. These fusible links shall be rated for 165 deg. F (74 deg. C) and shall be easily resettable for system testing.
6. Provide necessary relay to drop power to smoke damper motor when smoke detector at associated unit detects smoke and when unit is not running.
7. Provide all necessary wiring and devices to close dampers on a signal from the building fire alarm system.

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8. Provide area smoke detectors in the corridor arranged to activate the dampers.
- E. Locking Connection Straps: 1/2" wide positive locking steel straps or nylon self-locking straps. Panduit, Elgen, or accepted substitute.
 - F. Connection Fittings: Connections to non-metallic ducts manufactured sheet metal "spin-in" fittings. Genflex, Wiremold, Thermaflex, Glassflex, Clevepak, Schuller, or accepted substitute.
 - G. Access Doors In Sheet Metal Work:
 1. Hollow core double construction of same or heavier gauge material as duct in which installed. Use no door smaller than 12" by 12" for simple manual access or smaller than 18" by 24" where personnel must pass through infrequently. Use 24" by 60" minimum for filters and more frequent maintenance. Use indicated Ventlok hinges and latches or equivalent Elgen on all doors.
 - a. 100 Series hinges and latches on low pressure system doors up to 18" maximum dimension.
 - b. 200 Series on larger low pressure system doors and 333 series on high pressure systems.
 2. Construct doors up to 18" maximum dimension with 1" overlap, furr and gasket with 3/4" by 1/8" sponge rubber. Fit larger doors against 1-1/2" by 1/8" or angle frame and gasket with 3/4" by 1/8" sponge rubber or felt.
 - H. Opposed Blade Volume Damper: Install opposed blade volume damper in each zone supply duct on discharge of multi-zone units and where indicated on Drawings. Young No. 817 or accepted substitute.
 - I. Flexible Connections: Flexible duct connectors shall be used to isolate vibrations and noises that may be transmitted by fans or blowers to ductwork. The flexible duct connector is an air-tight and water proof flexible connection. Connectors will comply with NFPA 90A and NFPA 90B. Ventglass, Duro-Dyne, Elgen, or accepted substitute.
 1. Indoor Flexible Connector Fabrics:
 - a. Fire Retardant Neoprene coated Fiberglass resistant to chemicals, gasoline and grease:
 - 1) Meets NFPA 701
 - 2) Minimum Weight: 32 oz/sq.yd.
 - 3) Tensile Strength: 500 lbs in the warp and 500 lbs in the filling
 - 4) Service Temperature: -40 to 200 deg F
 - b. Fire Retardant Neoprene coated Fiberglass for high pressure applications and large ducts:
 - 1) Meets NFPA 701
 - 2) Minimum Weight: 40 oz/sq.yd.'
 - 3) Tensile Strength: 630 lbs in the warp and 465 lbs in the filling
 - 4) Service Temperature: 285 deg F
 2. Outdoor Flexible Connector: Glass Fabric coated with weatherproof Hypalon

resistant to UV Rays, ozone, chemicals, and grease.

- a. Meets NFPA 701
- b. Minimum Weight: 24 oz/sq.yd.
- c. Tensile Strength: 350 lbs in the warp and 250 lbs in the filling
- d. Service Temperature: -50 to 300 deg F

2.3 GRILLES, REGISTERS AND DIFFUSERS

- A. Description: Provide grilles, registers and diffusers as shown on the Drawings (new grilles or diffusers to match as closely as possible with existing).
- B. Finishes:
 1. Steel: Flat white enamel prime coat, factory applied on ceiling diffusers. Others are to have a baked enamel finish, color as selected by Architect.
 2. Aluminum: Anodized clear finish unless indicated otherwise.
- C. Manufacturers: Carnes, Krueger, Titus, Price, Nailor, Metalaire, and Tuttle & Bailey are accepted substitutes where only Titus model numbers are listed. Where other manufacturer's products are listed and/or "accepted substitute" is indicated, only the products or an accepted substitute for that item shall be provided.
- D. Perforated Face Diffusers: Perforated snap-in or concealed hinged face plate with internal deflection blades at diffuser neck in steel or extruded aluminum frame and margin to suit the ceiling construction. Provide with opposed blade volume damper. Panel size shall be 24" x 24" where lift-out tile ceiling system is indicated. Titus PCS.
- E. Ceiling Matched Return and/or Exhaust Register: To match adjacent ceiling outlets. Use in spaces containing ceiling diffusers and/or T-bar ceilings. Provide with damper except where dampered plenums are indicated. Match manufacturer of supply.
- F. Sidewall Supply Grille or Register: Double deflection grille with face bars parallel to long dimension on ceiling type and horizontal on wall type; bars to be individually adjustable, spaced on 0.66" to 0.75" centers; key operated opposed blade volume damper. Titus 300RL.
- G. Sidewall or Ceiling Return or Exhaust Register: Face bars parallel to long dimension on ceiling type and horizontal on wall type; bars set at 35 degrees to 45 degrees, spaced on 0.66" to 0.75" centers; key operated opposed blade volume damper. Titus 350RL Series.
- H. Louver Face Ceiling Diffusers: Rectangular type with pattern of distribution as indicated. Provide with opposed blade volume dampers. Titus TDC.
- I. Non-Ferrous Exhaust Registers: All anodized aluminum construction. Face bars parallel to long dimension on ceiling type and horizontal on wall type; bars set at 35 degrees to 45 degrees, spaced on 0.66" to 0.75" centers. Key-operated, opposed blade

volume damper. Fasten with aluminum screws. Install in shower rooms and adjacent areas and where shown on Drawings.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Air Handling Equipment Installation and Arrangement: Install and arrange as shown on Drawings. Comply with the manufacturer's recommendations for installation, connection, and start-up.
- B. Equipment Access Panels: Locate free of all obstructions such as ceiling bars, electrical conduit, lights, ductwork, etc.
- C. Filters: Install specified filters or accepted substitute temporary construction filters in supply units and systems prior to start-up or use for drying and/or temporary heat. Replace prior to acceptance of project.

3.2 INSTALLATION OF GRILLES, REGISTERS AND DIFFUSERS

- A. Size and air handling characteristics shall be as shown on the Drawings.
- B. Locate, arrange, and install grilles, registers and diffusers as shown on the Drawings. Locate registers in tee-bar ceilings with diffusers centered on the tile unless indicated otherwise.

3.3 DUCTWORK INSTALLATION

- A. Delivery, Storage and Handling:
 - 1. Protect shop fabricated and factory fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings with a polyethylene film with a high-tack pressure sensitive adhesive to attach to the ductwork and accessories.
 - 2. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with a polyethylene film with a high-tack pressure sensitive waterproof wrapping.
- B. Support: Install ductwork with 1" wide strap cradle hangers not more than 8' on centers or as required by code. Support terminal units independent of adjacent ductwork. Attach to available building construction according to good practices for materials involved. Manufactured hanger system acceptable in lieu of fabricated hangers at Contractors option. Ductmate "Clutcher" system or approved.
- C. Fan and Air Handling Unit Flexible Connections: Install flexible connections in ductwork at all rotating equipment.

- D. Elbows and Fittings: Construct elbows with throat radius equal to duct width in plane of turn or make them square and provide double wall, air foil turning vanes.
- E. Fittings: Make transitions and take-offs as shown on Drawings. Provide volume dampers and splitter dampers as indicated on Drawings and as specified. Saddle tees are not allowed.
- F. Acoustical Duct Lining: Acoustically line all fan unit intake and discharge plenums, all ductwork indicated as lined on the Drawings, all sheet metal ductwork specified per Section 23 0700 as insulated, where exposed to view or subject to damage in areas such as mechanical rooms, and, at the Contractor's option, all insulated ductwork specified in Section 23 0700. Line ducts with 1" thick lining for installation inside the building insulation envelope, and 1-1/2" for installation outside the building insulation envelope. Mechanically attach lining to sheet metal duct with Grip Nails or welding pins. Apply fire-retardant type water based adhesive on all leading edges, joints and seams. The duct size noted on the Drawings is the clear opening of the duct with lining. Insulation shall not reduce duct size listed.
- G. Manual Volume Dampers: Location of all volume dampers are not necessarily shown on the Drawings. Provide a minimum of one volume damper in each supply, return or exhaust branch. Install dampers in fiberglass ductwork (where fiberglass ductwork is allowed) with galvanized sheet metal sleeves of sheet metal gauges required for metal duct systems of the same dimensions.
- H. Duct Insulation: Specified in Section 23 0700.
- I. Sleeves: Provide galvanized sheet metal plaster ring around ductwork penetrating exposed finished walls. Sleeve and flash all duct penetrations through exterior walls in an air tight and weatherproof manner.
- J. Plenums: Construct sheet metal plenums and partitions of not lighter than 18 gauge galvanized steel and reinforce with 1-1/2" by 1/2" by 1/8" angles as required to prevent drumming or breathing.
- K. Access: Install necessary access opening and covers for cleaning, wiring or servicing motors, filters, fans, both entering and leaving air sides of coils, fire and/or smoke dampers and to other equipment located within or blocked by sheet metal work.
- L. Sealing: Caulk, seal, grout and/or tape ductwork and plenums to make airtight at seams, joints, edges, corners and at penetrations. Solder all seams, joints, etc., on all ductwork exposed to the weather. Install specified tape in accordance with manufacturer's requirements using degreaser on surfaces to be taped and wiped to eliminate moisture.
- M. Flexible Duct Connections:

1. Install in full extended condition, free of sags and kinks, using only the minimum length required to make the connection.
2. Make all joints and connections with 1/2" wide positive locking steel straps or nylon self-locking straps and make connections to non-metallic ducts with sheet metal sleeves or manufactured sheet metal "spin-in" fittings.
3. On vertically suspended ducts, secure with a minimum of three sheet metal screws on a maximum of 8" on center.

3.4 FIELD QUALITY CONTROL

- A. Disassemble, reassemble, and seal segments of systems as required to accommodate leakage testing and as required for compliance with test requirements.
- B. Conduct test, in presence of Architect, at static pressures equal to maximum design pressure of system or section being tested. If pressure classifications are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
- C. Determine leakage from entire system or section of system by relating leakage to surface area of test section.
- D. Maximum Allowable Leakage: Comply with requirements for Leakage Classification 3 for round and flat-oval ducts, Leakage Classification 12 for rectangular ducts in pressure classifications less than and equal to 2-inch wg (both positive and negative pressures).
- E. Remake leaking joints and retest until leakage is less than maximum allowable.
- F. Leakage Test: Perform tests according to SMACNA's "HVAC Air Duct Leakage Test Manual."

3.5 FIRE DAMPERS

- A. Provide fire dampers with rating equal to surrounding construction where penetrations are made through fire resistant rated construction per applicable codes and installed in accordance with UL label requirements. Locate fusible links for easy service or replacement and provide access panels of proper fire rating. Size fire dampers to maintain free area through fire damper same as unobstructed run of duct. Where dampers are installed in forced air systems which may not shut down under fire conditions, dampers shall be UL "dynamic-rated" dampers.

3.6 SMOKE DAMPERS

- A. Same as fire dampers above except provide complete wiring including electrical connections between field connected components and the fire alarm system specified in the electrical specifications.

3.7 NEW DUCTWORK CLEANING

- A. Store all ductwork materials on pallets or above grade, protected from weather, dirt/mud and other construction dust.
- B. Remove all accumulated dust, dirt, etc. from each duct section as it is being installed.
- C. Prior to installation of diffusers, grilles and registers, install temporary system filters and cover all diffuser, grille and register openings with temporary 25% efficiency filter materials and start the fan systems. Operate fans a minimum of 8 hours. Remove all temporary filters at the end of that period.
- D. Clean all diffusers, grilles and registers just prior to project final completion.

3.8 EXISTING DUCT CLEANING

- A. Power vacuum and air wash with compressed air the interior of the existing supply and exhaust ductwork, as noted on the Drawings, from the connection with new ductwork to the termination point at the supply or exhaust register. Ductwork cleaning shall be done by a subcontractor who is regularly engaged in this work. Powermaster or accepted substitute.

END OF SECTION

SECTION 23 3400 – HVAC FANS**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. Provide Fans as specified herein and shown on the Drawings.
- B. Equipment capacity and size as indicated in the equipment lists on the Drawings.
- C. Related Work: The requirements of Section 23 0500, Common HVAC Materials and Methods, also apply to this section.

1.2 QUALITY ASSURANCE

- A. Air Handling Equipment: Rated in accordance with AMCA certified rating procedures and AMCA labeled.

1.3 SUBMITTALS

- A. Submit catalog data, construction details and performance characteristics for each fan.
- B. Submit operating and maintenance data.

PART 2 - PRODUCTS**2.1 EXHAUST FANS AND UNITS**

- A. Roof Mounted Exhaust Fan (Belt Drive): Curb mounted on roof; vertical shaft, belt driven, open BI wheel as shown on Drawings with pressure lubricated ball bearings; ball bearing fan duty motor; vibration isolated; bird screen; weatherproof aluminum housing for mounting on square base; capacity as indicated on Drawings. [Provide with automatic belt tensioner.] Motor located outside the air stream. Casing to be easily removed for service. Motor and fan assembly to be mounted on rubber vibration isolators. Where indicated on the Drawings, provide motorized Class 1 damper in curb. Provide switch with pilot light for each fan so indicated. Provide factory mounted disconnect. Greenheck GB, Soler & Palau DB, Jen Fan DB, Carnes VEBK, Acme PV, PennBarry DOMEX, Cook ACE-B, Twin City BCRD, Captiveaire DD, or approved.
- B. Roof Mounted Exhaust Fan (Direct Drive): Curb mounted on roof; vertical shaft, direct driven, open BI wheel as shown on Drawings with permanently lubricated sealed ball bearings; fan duty motor; bird screen; weatherproof aluminum housing for mounting on square base; capacity as indicated on Drawings. Motor located outside the air stream. Casing to be easily removed for service. Motor and fan assembly to be mounted on rubber vibration isolators. Where indicated on the Drawings, provide motorized Class 1

damper in curb. Provide switch with pilot light for each fan so indicated. Provide factory mounted disconnect. Greenheck G, Soler & Palau RED, Jen Fan RED, Carnes VEDK, Acme PRN, PennBarry DOMEX, Cook ACE-D, Twin City DCRD, Captiveaire DR, or approved.

- C. Grease Hood Exhaust Fan: Curb mounted on roof; vertical shaft, belt driven, enclosed BI wheel as shown on Drawings with pressure lubricated ball bearings; ball bearing fan duty motor isolated from exhaust air stream. Low silhouette vertical discharge housing for mounting on square base. Capacity as indicated on Drawings. Provide switch with pilot light for each fan so indicated. Provide cleanout access, wired weatherproof disconnect switch, grease collection container, hinged base and ventilating curb. Acme Centri-Master, PennBarry FX, Acme PNU-RG, Carnes VUBA, Greenheck CUBE, ,” Breidert TXB, Jen Fan TXB, Cook VCR, Twin City DCRUR, CaptiveAire NCA, or approved.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and arrange equipment as shown on the Drawings and as recommended by the equipment manufacturer.

3.2 RESTORATION OF EXISTING HVAC EQUIPMENT

- A. General: Where "restoration" is indicated, include the following as minimum required work.
1. Replace fan wheel(s), motor(s), belts (matched set on multiple belt systems), sheave(s), and bearings.
 2. Replace magnetic starter(s) and overload protective devices.
 3. Replace filters matching existing filters unless indicated otherwise.
 4. Replace all gasketing on access panels and/or doors.
 5. Replace all control components including thermostat(s), sensor(s), ionization detectors, control valve(s), damper operator(s), pressure gauge(s), step or SCR controller(s) and thermometer(s).
 6. Clean coils, unit casing(s), plenum(s), fan scroll(s) and damper blades.
 7. Re-establish all original control sequences or where indicated, modify existing sequences as specified in Section 15900.
 8. Replace steam trap(s) and strainer element(s).
 9. Replace circuit setters, air vents, strainer element(s) and where indicated circulator(s).

3.3 ROOF MOUNTED EQUIPMENT INSTALLATION

- A. All roof mounted mechanical equipment shall be supported and seismically anchored on leveled, flashed and counterflashed curbs anchored to resist seismic forces and suitable for the roof construction. Minimum curb height shall be 12" above the roof unless

indicated otherwise on the Drawings. Flashing into the roof is specified in another Section.

- B. Make all piping, electrical and duct penetrations for each equipment within the curb unless shown otherwise on the Drawings. Piping and electrical conduit routed above and across the roof shall be supported on flashed and counterflashed curbs with pipe guides anchored to the curbs in "pitch pockets." Submit shop drawings on other arrangements for approval.

3.4 AIR HANDLING INSTALLATION

- A. Installation and Arrangement: Air handling equipment shall be installed and arranged as shown on the Drawings. Comply with the manufacturer's recommendations for installation connection and start-up.
- B. Lubrication: All moving and rotating parts shall be lubricated in accordance with the manufacturer's recommendations prior to start-up.
- C. Filters: Specified filters or approved temporary construction filters shall be installed in supply units prior to start-up or used for drying and/or temporary heat.

3.5 CONTROLS

- A. Wiring: All wiring shall be in accordance with the National Electrical Code and local electrical codes.

END OF SECTION

SECTION 23 7400 – PACKAGED HVAC UNITS**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. Provide Heating, Cooling, and Ventilating Equipment as specified herein and shown on the Drawings.
- B. Equipment capacity and size shall be as indicated on the Drawings.
- C. Related Work: The requirements of Section 23 0500, Common HVAC Materials and Methods, also apply to this section.

1.2 QUALITY ASSURANCE

- A. Air Handling Equipment: Rated in accordance with AMCA certified rating procedures and AMCA labeled.
- B. Air Conditioning, Heating, and Refrigeration Equipment Rating: Rated in accordance with AHRI certified rating procedures and AHRI labeled.
- C. Gas-fired Equipment: Design certified by American Gas Association.

1.3 SUBMITTALS

- A. Submit catalog data, construction details and performance characteristics for each HVAC unit.
- B. Submit operating and maintenance data.

PART 2 - PRODUCTS**2.1 ROOF MOUNTED HVAC EQUIPMENT**

- A. Packaged Roof-Mounted Gas Heating/Electric Cooling Unit:
 - 1. Manufacturers: Carrier, Daikin, Trane, York or approved.
 - 2. Supply Fan Section: Commercial class air condition duty, direct or belt driven centrifugal air supply fan.
 - 3. Heating Section: AGA and serving utility approved gas burner with aluminized steel heat exchanger. Include automatic gas valve, bonnet switch, high limit, main and pilot gas cocks, automatic electric and electronic ignition system, draft diverter and vent.
 - 4. Cooling Section: Include hermetic compressor, capacity matched vertical discharge, air cooled condenser, direct expansion cooling coil, complete

- refrigeration circuit, including high and low pressure cutouts, short cycling protection, refrigerant filter dryer, etc.
5. Casing: Enclose complete assembly in weatherproof formed steel enameled cabinet with 1" thick, non-organic casing insulation; 1" disposable air filters of standard sizes, extended housing for downward supply and return air ducts connections; 1/2" galvanized mesh bird screen over rain hood inlet. Mount unit on leveled factory furnished steel support curb with ductwork, electrical connections brought up through the roof within the curb.
 6. Economizer: Factory assembled and insulated outside air intake, relief and return air housing with automatic dampers for economizer operation. Assembly shall fit the HVAC unit specified above and shall be furnished complete with damper operators, bird screen over intake and relief air dampers. Unit to be dual Enthalpy control
 7. Controls: Minimum accessories shall include all necessary internal circuiting and fused disconnects for the following:
 - a. Single field electrical power connection.
 - b. Programmable 7-day, night set back, electronic thermostat and economizer/controller.
 - c. Automatic outside and return air damper controlled to maintain a set mixed air temperature with the outside air damper closing on fan shutdown and going to a minimum position above 60 deg. F (automatic minimum outside air intake damper to close on fan shutdown) and the thermostat shall operate the heating and cooling as required to maintain space temperatures.
 - d. Provide clear plastic guards with separate mounting base over thermostats indicated.
 8. Controls shall be as subsequently specified.
 - a. Economizer Logic Controller with Demand Control Ventilation (DCV): Where units with CO2 (DCV) and economizer control are shown, provide solid state economizer logic module to proportion outdoor and return air dampers to control for "free" cooling and for indoor ventilation CO2 levels. Unit to include inputs for one indoor CO2 sensor, dual enthalpy input (outdoor and indoor) (temperature input, and mixed air input. Unit to also include minimum and maximum damper potentiometers (to correspond to min ventilation OSA and max ventilation OSA), one ISI (Indoor sensor input – CO2 sensor) potentiometer (to correspond to CO2 sensor output derived from desired CO2 set point, 600ppm), and one exhaust fan potentiometer. Unit to modulate outdoor dampers based on ventilation demand and cooling demand. Honeywell W7215A/B or equal.
 - b. CO2 Sensor: Provide Duct (Wall) mounted CO2 sensor with LCD display. Unit range to be 0-2000ppm with an annual drift of not more than 20ppm. Analog output to be set for 500 to 1500ppm. Honeywell C7232 or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and arrange equipment as shown on the Drawings and as recommended by the

Salem Navigation Center
Salem, OR
Project # 21-0913
February 28, 2022

Merryman Barnes Architects Inc.

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equipment manufacturer.

- B. Piping: Refer to applicable sections for piping, ductwork, insulation, painting, etc.

3.2 ROOF MOUNTED EQUIPMENT INSTALLATION

- A. All roof mounted mechanical equipment shall be supported and seismically anchored on leveled, flashed and counterflashed **[vibration isolated]** curbs anchored to resist seismic forces and suitable for the roof construction. Minimum curb height shall be 12" above the roof unless indicated otherwise on the Drawings. Flashing into the roof is specified in another Section.
- B. Make all piping, electrical and duct penetrations for each piece of equipment within the curb unless shown otherwise on the Drawings. Piping and electrical conduit routed above and across the roof shall be supported on flashed and counterflashed curbs with pipe guides anchored to the curbs in "pitch pockets." Submit shop drawings on other arrangements for approval.
- C. Acoustical Protection: Install two layers of 5/8" weatherproof sheet rock with staggered joints on the perimeter angle and cross members provided with the vibration isolator bases. Apply sheet rock around all ductwork above the roof and caulk all joints and seams. Provide additional acoustical materials as recommended by Acoustical Engineer.

3.3 AIR HANDLING INSTALLATION

- A. Installation and Arrangement: Air handling equipment shall be installed and arranged as shown on the Drawings. Comply with the manufacturer's recommendations for installation, connection, and start-up.
- B. Lubrication: All moving and rotating parts shall be lubricated in accordance with the manufacturer's recommendations prior to start-up.
- C. Filters: Specified filters or approved temporary construction filters shall be installed in supply units prior to start-up or used for drying and/or temporary heat.

3.4 SMOKE DETECTOR INSTALLATION

- A. Provide duct-mounted smoke detectors at air handling units in accordance with Code requirements.
- B. Where detectors are mounted in a concealed location, provide remote indicating panel located as directed.
- C. Automatic Smoke Detector Fan Shutdown: Coordinate with Automatic Temperature Controls specified elsewhere in these specifications.

3.5 CONTROLS

- A. Wiring: All wiring shall be in accordance with the National Electrical Code and local electrical codes.
- B. Mounting: All controls intended to be operable by the occupants shall be mounted with the operating portion no more than 46" above the floor or as otherwise required by applicable codes.

END OF SECTION

SECTION 23 8000 – TERMINAL HVAC EQUIPMENT**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. Provide Heating, Cooling, and Ventilating Equipment as specified herein and shown on the Drawings.
- B. Equipment capacity and size shall be as indicated on the Drawings.
- C. Related Work: The requirements of Section 23 0500, Common HVAC Materials and Methods, also apply to this section.

1.2 QUALITY ASSURANCE

- A. Air Handling Equipment: Rated in accordance with AMCA certified rating procedures and AMCA labeled.
- B. Air Conditioning, Heating, and Refrigeration Equipment Rating: Rated in accordance with AHRI certified rating procedures and AHRI labeled.
- C. Gas-fired Equipment: Design certified by American Gas Association.

1.3 SUBMITTALS

- A. Submit catalog data, construction details and performance characteristics for each HVAC unit.
- B. Submit operating and maintenance data.

PART 2 - PRODUCTS**2.1 SMALL PACKAGED HVAC UNITS**

- A. Non-Ducted, Split System Cooling/Heat Pump Unit:
 - 1. Indoor Section: Non-ducted, compact fan coil unit designed for wall, ceiling, recessed ceiling, or concealed ducted mounting. Quantity, style, and capacity as listed on the drawings. Multispeed direct drive fan with adjustable discharge louvers and air filter. Indoor unit powered via outdoor unit. Provide with wired or wireless thermostat as indicated.
 - 2. Outdoor Section: Capacity matched with indoor section(s), steel cabinet with hermetically sealed compressor(s), accumulator, crankcase heater, high and low pressure switches, restart delay relay, condenser coil, and propeller fans. Low

ambient operation to 20 degrees. Single or multiple circuit as indicated. Provide preinsulated lineset for each indoor unit.

3. Acceptable Manufacturers: Carrier, Trane, LG, Sanyo, Mitsubishi, or approved.

2.2 ELECTRIC TERMINAL EQUIPMENT

- A. Wall mounted electric fan forced heaters: UL listed recessed heater with primary and secondary thermal safeties with secondary manual reset, nichrome heating element, recessed wall can, two stage centrifugal blower, and powder coat metal grille. Provide with remote 2-pole [programmable electronic] thermostat. Cadet C series, Qmark, Markel, King approved.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and arrange equipment as shown on the Drawings and as recommended by the equipment manufacturer.
- B. Piping: Refer to applicable sections for piping, ductwork, insulation, painting, etc.

3.2 ROOF MOUNTED EQUIPMENT INSTALLATION

- A. All roof mounted mechanical equipment shall be supported and seismically anchored on leveled, flashed and counterflashed curbs anchored to resist seismic forces and suitable for the roof construction. Minimum curb height shall be 12" above the roof unless indicated otherwise on the Drawings. Flashing into the roof is specified in another Section.
- B. Make all piping, electrical and duct penetrations for each equipment within the curb unless shown otherwise on the Drawings. Piping and electrical conduit routed above and across the roof shall be supported on flashed and counterflashed curbs with pipe guides anchored to the curbs in "pitch pockets." Submit shop drawings on other arrangements for approval.
- C. Acoustical Protection: Install two layers of 5/8" weatherproof sheet rock with staggered joints on the perimeter angle and cross members provided with the vibration isolator bases. Apply sheet rock around all ductwork above the roof and caulk all joints and seams. Provide additional acoustical materials as recommended by Acoustical Engineer.

3.3 AIR HANDLING INSTALLATION

- A. Installation and Arrangement: Air handling equipment shall be installed and arranged as shown on the Drawings. Comply with the manufacturer's recommendations for installation connection and start-up.

- B. Lubrication: All moving and rotating parts shall be lubricated in accordance with the manufacturer's recommendations prior to start-up.
- C. Filters: Specified filters or approved temporary construction filters shall be installed in supply units prior to start-up or used for drying and/or temporary heat.

3.4 CONDENSATE DRAINAGE

- A. Provide complete condensate drainage system. Route condensate to approved interior receptor. Discharging condensate to the exterior is not permitted.

3.5 CONTROLS

- A. Wiring: All wiring shall be in accordance with the National Electrical Code and local electrical codes.
- B. Mounting: All controls intended to be operable by the occupant shall be mounted with the operating portion no more than 46" above the floor or as otherwise required by applicable codes.

END OF SECTION